GeoScience Abstracts

Vol. 1, No. 5 May 1959

published monthly by the
AMERICAN GEOLOGICAL INSTITUTE

GEOSCIENCE ABSTRACTS
published by the
American Geological Institute

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GeoScience Abstracts is published monthly, beginning with Volume 1, Number 1, January 1959, and replaces Geological Abstracts which was discontinued by the Geological Society of America at the end of 1958. The journal has received a grant in aid from the National Science Foundation to provide initial working funds.

GeoScience Abstracts will work toward complete coverage of all significant North American literature in geology, solid earth geophysics and related areas of science. It will also include abstracts in English of Soviet literature, particularly from the Referativnyi Zhurnal, as the translations are processed by the AGI Translation Center. The journal will have a monthly author index and an annual subject index.

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American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
Better Roads. Chicago.
California, University, Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Dept. of Mines and Technical Surveys, Geographical Branch, Memoir. Ottawa.
Canada, Dominion Observatory, Contribution; Publication. Ottawa.
Canada, Geological Survey, Map; Memoir; Paper. Ottawa.
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Geographical Bulletin (Canada, Dept. of Mines and Technical Surveys, Geographical Branch). Ottawa.
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Geological Society of America, Bulletin; Special Paper. New York.
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Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
Journal of Sedimentary Petrology. Tulsa, Oklahoma.
Kansas, State Geological Survey, Bulletin; Oil and Gas Investigations. Lawrence, Kansas.
Los Angeles County Museum, Contributions in Science. Los Angeles.
Maine Geological Survey, Mineral Resources Reference Map. Augusta, Maine.
Michigan, Geological Survey Division, Progress Report; Water Supply Report. Lansing, Michigan.
Military Engineer (Society of American Military Engineers). Washington, D. C.
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Research Council of Alberta, Geological Division, Map. Edmonton, Alberta.
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Seismological Society of America, Bulletin. Berkeley, California.
Société Géologique de France, Compte Rendu. Paris.
South Carolina, State Development Board, Division of Geology, Bulletin. Columbia, South Carolina.
Southwestern Louisiana Journal (Southwestern Louisiana Institute of Liberal and Technical Learning). Lafayette, Louisiana.
Texas, University, Publication. Austin, Texas.
Texas, University, Bureau of Economic Geology, Geologic Quadrangle Map; Report of Investigations. Austin, Texas.
U. S. Geological Survey, Bulletin; Geologic Quadrangle Map; Mineral Investigations Map; Miscellaneous Investigations Map; Professional Paper; Water-Supply Paper. Washington, D. C.
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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1-1068. Lang, A. H. METALLOGENIC MAP, URANIUM IN CANADA: Canada, Geol. Survey, Map 1045A - M 1, scale 1:7,603,200, explanatory notes and list of localities, 1958, 43 refs.

This is a simplified map of Canada printed on transparent paper on which known U occurrences are overprinted. The various types of occurrence are distinguished, and their importance is indicated. In addition to the known occurrences, areas considered to be favorable are indicated. --H. M. A. Rice.

1-1069. Vokes, F. M. METALLOGENIC MAP, BERYLLIUM IN CANADA: Canada, Geol. Survey, Map 1045A - M2, scale 1:7,603,200, explanatory notes and list of localities, 1958, 29 refs.

This is a simplified map of Canada printed on transparent paper on which the known occurrences of Be are shown in an overprint. The various types of occurrence are distinguished. --H. M. A. Rice.

1-1070. Vokes, F. M. METALLOGENIC MAP, MOLYBDENUM IN CANADA: Canada, Geol. Survey, Map 1045A - M 3, scale 1:7,603,200, explanatory notes and list of 282 localities, 1959, 163 refs.

Outline map of Canada printed on transparent paper, with occurrences of Mo shown in an overprint. Five categories of deposits are distinguished, but no effort is made to indicate relative importance. Enclosed with the map is a mimeographed list of references. --H. M. A. Rice.

1-1071. Norris, D. K. LIVINGSTONE RIVER, WEST OF THE FIFTH MERIDIAN, ALBERTA: Canada, Geol. Survey, Map 5-1958, scale 1 in. to 1 mi., marginal notes, 1958.

Preliminary series geological map of about 190 sq. mi. in the foothills of southern Alberta. The trace of the Livingstone thrust fault crosses the center of the area in a NNW. direction, the western half of the area being underlain by the Livingstone thrust sheet. The Livingstone thrust itself is a low angle fault from which many steeper splays emerge to divide the overlying sheet into numerous thin, narrow slices. The underlying block is similarly sliced by innûmerable steep-dipping faults. This whole complex structure is further complicated by folding.

The strata involved in this deformation are Carboniferous, Permian, Jurassic, and Cretaceous and comprise calcareous, argillaceous, and arenaceous sediments.

No oil or gas has as yet been found, but coal seams are present in some of the Cretaceous beds. --H. M. A. Rice.

1-1072. Godfrey, John D. AERIAL PHOTOGRAPHIC INTERPRETATION OF PRECAMBRIAN STRUCTURES NORTH OF LAKE ATHABASCA: Research Council Alberta, Geol. Div., Map 25, scale 1:126,720, 1958.

This map, in 2 colors, presents new structural information over 3,600 sq. mi. of the Precambrian Canadian Shield in the extreme NE. corner of Alberta. The area is on the western periphery of the Shield and is covered to the W. by overstep of the Paleozoic sediments of the western Canada sedimentary basin. The study is based on the examination of over 700 vertical aerial photographs. Structural features distinguished on the map are regional faults, minor faults, fractures, shear zones, and folds. The study of geological linears is completed by the outline of sand dune and glacial fluting data. Previous geological work has been carried out in only limited parts of the area. --Auth.

1-1073. Godfrey, John D. ECONOMIC MINERALS IN THE ANDREW, WAUGH AND JOHNSON LAKE AREA, NORTHEASTERN ALBERTA: Research Council Alberta, Geol. Div., Map 58-4, scale 1:63,360, 1958.

Mineralization was encountered in the course of geological work on the Precambrian Canadian Shield in the extreme NE. corner of Alberta. The area covered is 150 sq. mi. situated approximately 45 mi. W. of Uranium City, Saskatchewan. The mineralization is referred to in detail in an accompanying report. Mineralization indicated includes molybdenite, U, arsenopyrite and smaltite with Ni. It is the first report of mineralization in this map-area of Alberta. Important fault structures and bands of metasedimentary rock are also shown. --Auth.

1-1074. Irish, Ernest J. W. CHARLIE LAKE, WEST OF SIXTH MERIDIAN, BRITISH COLUMBIA: Canada, Geol. Survey, Map 17-1958, scale 1 in. to 4 mi., marginal notes, 1958.

Geological map of some 5,300 sq. mi. in the Peace River district of eastern British Columbia. The area is in the central plains, except for the western margin which laps onto the front edge of the foothills. The entire area is underlain by Cretaceous sediments, flat-lying Upper Cretaceous marine and nonmarine beds over the northeastern three-quarters of the area and Lower Cretaceous marine beds along Peace River and in the SW. corner of the area. The latter beds are also flat lying except in the foothills where they are folded and faulted in a northwesterly direction.

The area is of great economic importance as it contains the large Fort St. John gas field and several smaller fields. Boundary Lake is the only oil field known as yet, but several wells elsewhere in the area are producing oil. --H. M. A. Rice

1-1075. Souther, J. G. CHUTINE, CASSIAR DISTRICT, BRITISH COLUMBIA: Canada, Geol. Survey, Map 7-1959, scale 1 in. to 4 mi., marginal notes, 1959.

Preliminary series geological map of some 1,200 sq. mi. of mountainous terrain on the Alaska border, W. of Telegraph Creek and N. of Wrangell, Alaska. The area extends into the heart of the Coast Mountains and much of it is covered with permanent ice and snow. The oldest rocks in the area are late Paleozoic sediments that occur here and there in the foothills. These are overlain by Triassic volcanic and sedimentary rocks. The heart of the Coast Mountains is composed of granitic rocks and gneisses and schists of Triassic age, but probably including older rocks. The gneisses and schists occupy only small areas along the Alaska boundary, but are more extensive on the flank of the mountains both in the N. and the S. The granitic rocks are not restricted to the main ranges, but form large bodies in the sedimentary

and volcanic rocks in the foothills. Molybdenite was seen at 4 places, one of which has been partly explored. --H. M. A. Rice.

1-1076. Rice, H. M. A. VICTORIA - VANCOUVER, BRITISH COLUMBIA: Canada, Geol. Survey, Map 1069A, scale 1:506,880, 1959.

This is a map of southwestern British Columbia, including the southern tip of Vancouver Island, on which has been compiled the information from published and unpublished geological maps of the Geological Survey of Canada and the British Columbia Dept. of Mines. The area is covered by volcanic and sedimentary rocks ranging in age from Permian to Tertiary. These have been intruded by granitic bodies, many of batholithic size, that in all underlie about half of the area. --Auth.

1-1077. Poole, W. H. NAPADOGAN, YORK COUNTY, NEW BRUNSWICK: Canada, Geol. Survey, Map 11-1958, scale 1 in. to 1 mi., marginal notes, 1958, 4 refs.

Preliminary series geological map of some 410 sq. mi. in central New Brunswick. Most of the area is underlain by a series of northeasterly trending belts of steeply dipping sediments of Ordovician(?) and Silurian age. These are intruded by numerous, presumably Devonian, diorite dikes and sills. These are overlain by early Carboniferous conglomerates and arenaceous sediments, with, at the top, some basalt flows. Overlapping these, so that in most places the lavas are missing, are sediments of Pennsylvanian age which occupy most of the SE. corner of the area. --H. M. A. Rice.

1-1078. Neale, E. R. W. BAIE VERTE, WHITE BAY AND GREEN BAY DISTRICTS, NEWFOUNDLAND: Canada, Geol. Survey, Map 10-1958, scale 1 in. to 1 mi., marginal notes, 1958, 2 refs.

Preliminary series geological map of some 390 sq. mi. on the N. coast of Newfoundland. Most of the area is underlain by volcanic rocks (mainly) of probable Ordovician age intruded by granitic rocks, probably of Devonian age. On the W., mainly in fault contact with the younger rocks, is an extensive body of gneissic rocks of probable Precambrian age. A smaller area of similar rocks in the NE. corner of the area is unconformably overlain by the Ordovician (?) rocks. Bodies of serpentinized peridotite of probable Ordovician age intrude the Precambrian(?) gneisses and Ordovician(?) volcanic rocks. The rocks in the area are complexly folded and faulted, with a general northeasterly alignment, particularly across the center of the area along the contact between the Precambrian(?) gneisses and the younger rocks.

Pyrite, Cu, and Au have been produced in this area, and other occurrences of these are known or likely to be found. Cross-fibre asbestos and chromite occur in the peridotite. --H. M. A. Rice.

1-1079. Blackadar, Robert G. FOXE BASIN NORTH, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 4-1958, scale 1:506,880, marginal notes, 1958, 4 refs.

Preliminary geological map of a reconnaissance on W. coast of Baffin Island at the N. end of Foxe Basin. Most of the region is underlain by granitic rocks with, here and there, intercalated patches of metamorphosed sediments, all probably of Archean age. Sparsely fossiliferous limestone of Ordovician or Silurian age occurs in small widely scattered patches.

Well-defined raised beaches occur as much as 400 ft. above present sea level. A radiocarbon date for archeological material suggests a rate of emergence of about 4.5 ft. a century. --H. M. A. Rice.

1-1080. Blackadar, Robert G. FURY AND HECLA STRAIT, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 3-1958, scale 1:506,880, marginal notes, 1958, ref.

Preliminary geological map of a reconnaissance on the NW. part of Baffin Island, overland from the head of Admiralty Fiord S. to the coast and along the northern edge of Melville Peninsula. Most of the region is underlain by granitic rocks, and a small extent of associated metamorphosed sedimentary and volcanic rocks, all of probable Archean age. Overlying these unconformably are clastic sediments and some limestone and dolomite occupying a synclinal basin whose axis roughly follows Fury and Hecla Strait. These are of Proterozoic or early Paleozoic age. Here and there the Archean(?) rocks are overlain by flat-lying limestone and dolomite beds. These are largely unfossiliferous, but Ordovician fossils have been found in places. Some parts may be Silurian. --H. M. A. Rice.

1-1081. Brown, I. C. GEOLOGICAL MAP OF THE DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 1055A, scale 1:1,267,000, 1958.

This is a compilation map of existing information covering the western third of the Northwest Territories from 102°W. to the Yukon boundary and from 60°N. to the Arctic Ocean. The western half of the area is underlain by rocks of the Canadian Shield. Most of these comprise granitic gneisses and allied rocks with small amounts of volcanic and sedimentary rocks, all of Archean age. Overlying these are many small areas of Proterozoic volcanic and sedimentary rocks. All these are variously faulted and folded. Lapping on to the Canadian Shield and extending W. to the Yukon boundary is a thick succession of Paleozoic rocks, mainly limestone and dolomite, with some argillaceous and arenaceous sediments, overlain here and there by Cretaceous sediments. Information on this part of the area is particularly scanty and the structure not too well known. --H. M. A. Rice.

1-1082. Fraser, J. A. FORT ENTERPRISE, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 16-1958, scale 1 in. to 4 mi., marginal notes, 1958.

Geological map of some 3,200 sq. mi. of the Canadian Shield N. of Yellowknife. Most of the area is underlain by granitic rocks of Precambrian age. Crossing the E. half of the area is a N.-trending belt of older sedimentary and volcanic rocks of Archean age partly altered to quartz-biotite and hornblende schists. These have been assigned to the Yellowknife group. A few narrow lenses of these rocks also occur here and there among the granitic rocks. There is ample evidence that most of the gneissic members of the granitic unit have been formed from the Yellowknife rocks by the addition of granitic material. --H. M. A. Rice.

1-1083. Canada, Geological Survey. AERO-MAGNETIC MAP BOYD LAKE, NORTHWEST TERRITORIES: Its: Map 1073A, scale 1:253,440, marginal notes, 1959.

This map is compiled from previously issued maps on a smaller scale recording the results of airborne magnetometer surveys by the Geological Survey of Canada. Six levels of magnetic intensity are shown by different shades of color. Although the geology is not shown, an attempt is made in the marginal notes to show the relation between the magnetic trends and the underlying geology. The general northeasterly trend of the structures and formations in the SE. half of the area is clearly indicated. --H. M. A. Rice.

1-1084. Weeks, Ludlow J. MIRA, CAPE BRETON AND RICHMOND COUNTIES, CAPE BRETON ISLAND, NOVA SCOTIA: Canada, Geol. Survey, Map 1056A, scale 1:63,360, marginal notes, 1958, ref.

Geological map of 420 sq. mi. of southeastern Cape Breton. Rocks in the area have a generally northeasterly trend with possible Precambrian volcanic and metamorphic rocks underlying the eastern margin. Overlying these on the W. is a succession of Cambrian shales and limestones with some more arenaceous facies to the S. Overlying the latter are some conglomerates and sandstones of possible Silurian or Devonian age. Some of the possibly Precambrian volcanic rocks are repeated in the northwestern corner of the area. All of these are intruded by granitic bodies of various size. All of the above-mentioned rocks are overlain unconformably by various size patches of Mississippian and Pennsylvanian sediments. The later rocks contain coal seams, and some coal has been extracted. --H. M. A. Rice.

1-1085. Holman, R. H. C. HEAVY METALS IN STREAM SEDIMENTS, NORTHERN MAINLAND OF NOVA SCOTIA: Canada, Geol. Survey, Map 7-1958, scale 1 in. to 4 mi., 2 sheets, marginal notes, 1958.

This preliminary map shows the results of continuation of the investigation described in Geological Survey of Canada Paper 58-1 [GeoScience Abstracts 1-962] and is based on field analyses only. A general background amount of heavy metal was established, and concentrations greater than 4 p. p.m. expressed as Zn were considered anomalous. Several areas in which anomalous results are general occur, particularly along the N. side, and deserve exploration. --H. M. A. Rice.

1-1086. Sanford, B. V. GEOLOGICAL MAP OF SOUTHWESTERN ONTARIO SHOWING OIL AND NATURAL GAS PRODUCING AREAS: Canada, Geol. Survey, Map 1062A, scale 1:380,160, 1958.

This map covers almost the entire part of southwestern Ontario covered by Paleozoic rocks. The entire succession ranging from Ordovician to Mississippian appears. The formations dip gently to the SW. and outcrop in northwesterly trending belts. They appear in orderly succession from the edge of the Canadian Shield in the NE. to the crest of a gentle syncline that runs from the southern tip of Lake Huron across to Lake Erie. SW. of this the formations are repeated. Three typical columnar sections are shown on the map, and the principal oil and natural gas producing fields are identified together with the producing formation, the depth of the productive zones, the type of structure or trap, and the total production. --H. M. A. Rice.

1-1087. Wright, J. F. SUDBURY, ONTARIO: Canada, Geol. Survey, Map 1063A, scale 1:506,880, 1958.

This is a compilation of existing geological maps on an area that includes the Sudbury basin in the SE. corner. The area is underlain by a complex succession of Archean and Proterozoic sedimentary, volcanic, metamorphic, and granitic rocks. A small area of Ordovician sediments lies along the southern boundary mainly on islands in Lake Huron. The source maps used in making this compilation are listed. --H. M. A. Rice.

1-1088. Bostock, J. M. DRIFT-THICKNESS CONTOURS, CITY OF OTTAWA (WEST PART), CARLETON COUNTY, ONTARIO: Canada, Geol. Survey, Map 13-1958, scale 1 in. to 1,000 ft., marginal notes, 1958.

Information based on borings and excavations shows that the thickness of overburden varies from 1 or 2 ft. over much of the area to 30 or 40 ft. locally, and over 60 ft. at one place. --H. M. A. Rice.

1-1089. Duffell, Stanley, and R. A. Roach. MOUNT WRIGHT, QUEBEC-NEWFOUNDLAND: Canada, Geol. Survey, Map 6-1959, scale 1 in. to 4 mi., cross-sec., marginal notes, 1959.

Preliminary series geological map of some 2,900 sq. mi. on the Quebec-Labrador boundary, at the southwestern end of the so-called Labrador Trough. The central and northwestern parts of the area are underlain by granitic rocks and gneisses of early Proterozoic and probably Archean age. Partly interbedded with these rocks and partly apparently overlying them is a succession of marble, quartzite, metamorphosed chert, and iron formation, and a much more extensive sequence mainly of hornblende-garnet gneiss. There are also some gabbroic intrusive rocks. The entire area lies geologically within the Grenville sub-province. Typically the rocks have been folded into complex, variously striking structures.

Thousands of claims have been staked in the area in the past 5 years, and active exploration of the iron deposits has been carried out by the major iron and steel companies of Canada and the United States.--H. M. A. Rice.

1-1090. Kindle, E. D., and G. C. Riley. BROCK RIVER, ABITIBI AND MISTASSINI TERRITORIES AND ABITIBI COUNTY, QUEBEC: Canada, Geol. Survey, Map 1060A, scale 1:253,440, marginal notes, 1958, 4 refs.

Geological map of some 3,050 sq. mi. immediately W. of Lake Mistassini in central Quebec. The entire area is underlain by rocks of the Canadian Shield. The northern four-fifths consists of granitic rocks with a large, irregularly shaped area of older volcanic rocks in the N. central part. Along the southern border of the area is a series of easterly trending belts of Archean lavas, conglomerate, graywacke, and arkose, all intruded by granitic rocks and some gabbro. Several northeasterly trending faults cut all rocks. --H. M. A. Rice.

1-1091. Canada, Geological Survey. SASKATCHEWAN AND WESTERN MANITOBA, SHOWING

OIL AND GAS FIELDS AND OIL AND GAS DISCOVERIES: 4th ed., Its: Map 1044A, scale 1:1,267,200, 1958.

This map, which is annually revised, does not show geology but gives the shape and position of all known oil and gas fields, new discoveries of oil and gas, pipe lines constructed, and position of refineries. The stratigraphic position of producing beds is also shown. --H. M. A. Rice.

1-1092. Newton, John G. PROFILE SHOWING GEOLOGY ALONG STATE HIGHWAY 25, MARENGO COUNTY, ALABAMA: Alabama, Geol. Survey, Map 11, scale 4 in. to 1 mi., 1959.

Formations along profile include the Demopolis chalk and the undifferentiated Ripley formation and Prairie Bluff chalk, of Late Cretaceous age; and the Clayton, Porters Creek, Naheola, and Nanafalia formations and Tuscahoma sand, of Tertiary age. The Eutaw formation and the Mooreville chalk of Late Cretaceous age, which crop out north of Marengo County, are shown where penetrated in wells near the highway. The formations strike northwestward and dip southwestward at the rate of 40 to 50 ft. per mile. [Also included is a brief discussion on the economic geology, including ground water, petroleum, lightweight aggregate, sand, gravel and chalk.]--Auth.

1-1093. Plafker, George, and Don J. Miller. GLACIAL FEATURES AND SURFICIAL DEPOSITS OF THE MALASPINA DISTRICT, ALASKA: U. S. Geol. Survey, Misc. Inv. Map I-271, scale 1:125,000, 1958, pub. 1959.

Malaspina Glacier and its tributary glaciers, surficial deposits, and bedrock areas as interpreted and plotted from vertical aerial photographs are shown on this map. Morainic banding, crevasses and other surface features of the glaciers are delineated. Surficial deposits are differentiated into 12 units according to inferred lithologic character, mode of origin, and relative age. A brief text summarizes the recent history of glaciation and deposition in the Malaspina district and the adjoining Icy Bay and Yakutat Bay. --U. S. Geol. Survey.

1-1094. Hackman, R. J. YELLOW JACKET QUADRANGLE, MONTEZUMA AND DOLORES COUNTIES, COLORADO [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-281, scale 1:24,000, lat. 37°30'-37°45'N., long. 108°30'-108°45'W., 1959.

1-1095. Marshall, C. H. DELTA QUADRANGLE, MONTROSE AND DELTA COUNTIES, COLORADO [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-282, scale 1:24,000, lat. 38°30'-38°45'N., long. 108°-108°15'W., 1959.

1-1096. Marshall, C. H. NORWOOD-1 QUADRANGLE, MONTROSE AND OURAY COUNTIES, COLORADO [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-283, scale 1:24,000, lat. 38°15'-38°30'N., long. 108°-108°15'W., 1959.

1-1097. Merriam, Daniel F., Richard L. Winchell, and William R. Atkinson. PRELIMINARY REGIONAL STRUCTURAL CONTOUR MAP ON TOP OF THE LANSING GROUP (PENNSYLVANIAN) IN KANSAS: Kansas, State Geol. Survey, Oil & Gas Inv. no. 19, scale approx. 1:600,000, contour interval 50 ft., 1958.

Shows also surface and subsurface limits of Lansing group, surface and well control points, and oil and gas fields. --R. H. King.

1-1098. Doyle, Robert G. MINERAL RESOURCES OF MAINE - LEWISTON SHEET: Maine Geol. Survey, Mineral Resources Reference Map 2, scale approx. 1 in. to 4 mi., Feb. 1959.

This 13" x 17" 3-color map is the second of a series adopted for use as a reference source in locating mineral occurrences in Maine and literature describing such occurrences. Shown on the map, which features towns, roads, streams, ponds, and topographic contours, are 118 occurrences of such resource types as granites, pegmatites (feldspar-quartz-mica, etc.), metals, diatomite, peat, and so forth. Each occurrence is keyed to an index which details sources of literature for said occurrence. The map covers approximately 3400 sq. mi. in western Maine from Fryeburg and Lisbon Falls on the south to Kingfield and Rangeley on the N., at a scale of 1" = about 4 mi. --Auth.

1-1099. Segerstrom, Kenneth. SHELBURNE FALLS, MASSACHUSETTS: SURFICIAL GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-116, scale 1:31,680, contour interval 10 ft., lat. 42°30'-42°37'30"N., long. 72°37'30"-72°45'W., 1959.

This report concerns an area of about 55 sq. mi. in the northeastern part of the Berkshire Hills of Massachusetts. The surficial deposits are of glacial origin. Two tills are distinguished; together they cover about 65% of the area. Several sequences of glacial stream and lake deposits are mapped. Many of the glaciofluvial features are related to glacial Lake Hitchcock. --U. S. Geol. Survey.

1-1100. Hayes, P. T., and R. L. Koogle. CARLSBAD CAVERNS WEST, NEW MEXICO-TEXAS: U. S. Geol. Survey, Geol. Quad. Map GQ-112, scale 1:62,500, contour interval 50 ft., lat. 32°-32°15'N., long. 104°30'-104°45'W., 1958, pub. 1959.

This area, covering about 250 sq. mi., includes a large part of Carlsbad Caverns National Park, which is underlain by the Capitan limestone and associated formations that are of particular interest in oil and gas exploration in southeastern New Mexico and W. Texas. Subsurface structure is shown by structural contours and a structure section. Accompanying the map are a stratigraphic diagram and sections and a brief text summarizing the geology of the area. --U. S. Geol. Survey.

1-1101. Oakes, Malcolm C. GEOLOGIC MAP OF CREEK COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Map C-5, scale 1:63,360, Nov. 1958.

The map shows in color the distribution of 16 formations and of numerous members. The bed rock is Desmoinesian, Missourian and Virgilian. The area is in the Eastern Sandstone Cuesta Plains physiographic district. --C. C. Branson.

1-1102. Quinn, Alonzo W. PROVIDENCE, RHODE ISLAND: BEDROCK GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-118, scale 1:24,000, contour

interval 10 ft., lat. 41°45'-41°52' 30"N., long. 71°22'30"-71°30'W., 1959.

The western one-third of the quadrangle is underlain by schist, quartzite, and other rocks of the Precambrian(?) Blackstone series and by diorite, quartz diorite, granodiorite, and granite of Devonian or older age. The eastern two-thirds is underlain by Pennsylvanian conglomerate, sandstone, shale, and meta-anthracite of the Narragansett Basin. The text describes the formations and discusses their structural relationships, ages, metamorphism, and origins; also the economic and engineering geology of the area. --U. S. Geol. Survey.

1-1103. Oetking, Philip F., comp. GEOLOGICAL HIGHWAY MAP OF TEXAS: scale 1 in. to 30 mi., Dallas, Texas, Dallas Geological Society, 1959.

The map was published by the Dallas Geological Society (P. O. Box 253, SMU Station, Dallas 5, Texas. Price of map $1.00) under the auspices of the field trip committee for the meeting of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists, Dallas, Texas, 1959. The outcrop pattern of 26 rock units is shown in 19 colors overprinted on the Texas State Highway network. The map includes a time and rock unit chart, mileage chart, and index of counties, cities, and towns.

1-1104. Amsbury, David L. GEOLOGY OF THE PINTO CANYON AREA, PRESIDIO COUNTY, TEXAS: Texas, Univ., Bur. Econ. Geology, Geol. Quad. Map, no. 22, scale 1:63,360, 3 struct. secs. and text on map sheet, Nov. 1958, pub. Jan. 1959.

In this area bordering the Rio Grande in Trans-Pecos Texas, bedrock includes Permian and Comanchean sedimentary rocks and Tertiary intrusive, volcanic, pyroclastic, and sedimentary rocks. Younger surficial deposits include bolson fill, terrace deposits, colluvium, and alluvium. Rock units are shown in color, and the text discusses stratigraphy, structure, and economic geology. --J. T. Lonsdale.

1-1105. Hackman, R. J. COACH CREEK NE QUADRANGLE, GRAND COUNTY, UTAH, AND MESA COUNTY, COLORADO [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-279, scale 1:24,000, lat. 38°52'30"-39°N., long. 109°-109°07' 30"W., 1959.

1-1106. Hackman, R. J. COACH CREEK SE QUADRANGLE, GRAND COUNTY, UTAH, AND MESA COUNTY, COLORADO [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-278, scale 1:24,000, lat. 38°45'-38°52'30"N., long. 109°-109° 07'30"W., 1959.

1-1107. Hemphill, W. R. MOUNT ELLEN-4 QUADRANGLE, WAYNE COUNTY, UTAH [photogeologic map]: U. S. Geol. Survey, Misc. Inv. Map I-280, scale 1:24,000, lat. 38°22'30"-38°30'N., long. 110°52'30"-111°W., 1959.

1-1108. Lewis, R. Q., Sr., and R. H. Campbell. PRELIMINARY GEOLOGIC MAP OF THE ELK RIDGE 3 NE QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-194, scale 1:24,000, contour interval 40 ft., lat. 37°37'30"-37°45'N., long. 109°45'-109°52'30"W., 1959.

1-1109. Mullens, T. E. PRELIMINARY GEOLOGIC MAP OF THE CLAY HILLS 2 NW QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-185, scale 1:24,000, contour interval 40 ft., lat. 37°22'30"-37°30'N., long. 110°22'30"-110°30'W., 1959.

1-1110. Mullens, T. E. PRELIMINARY GEOLOGIC MAP OF THE CLAY HILLS 2 SW QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-186, scale 1:24,000, contour interval 40 ft., lat. 37°15'-37°22'30"N., long. 110°22'30"-110°30'W., 1959.

1-1111. Kramer, W. B., C. E. Dobbin, and Robert McMillan. GEOLOGIC MAP AND SECTIONS OF LANCE CREEK OIL AND GAS FIELD AND VICINITY, NIOBRARA COUNTY, WYOMING: U. S. Geol. Survey, General Mineral Resource Map, scale 1 in. to 1 mi., 1943, reprinted 1959.

1-1112. Bramkamp, R. A., and L. F. Ramirez. GEOGRAPHIC MAP OF THE NORTHWESTERN RUB' AL KHALI QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-213 B, scale 1:500,000, lat. 20°-24°N., long. 48°-51°E., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Igneous and Metamorphic Petrology 1-1248, 1-1249; Geohydrology 1-1269, 1-1270, 1-1272, 1-1273; Mineral Deposits 1-1286, 1-1289, 1-1295, 1-1296.

1-1113. Douglas, R. J. W. MOUNT HEAD MAP-AREA, ALBERTA: Canada, Geol. Survey, Mem. 291, 241 p., 26 figs. (2 col.), 10 pls., Map 1052A, scale 1:63,360, 1958, refs.

The area is in the foothills of southwestern Alberta and includes Devonian, Mississippian, Pennsylvanian (?), Triassic, Jurassic, and Cretaceous rocks. The report gives detailed structural analysis and comparison with adjacent regions, with special emphasis on petroleum possibilities. Special emphasis given to stratigraphy of Mississippian rocks. The Rundle formation is raised to group status to include 3 new formations, Livingstone, Mount Head, and Etherington formations. Faunal evidence shows Livingstone to be of Osagean, Mount Head of Meramecian, and Etherington of Chesterian age. Two appendices give detailed description of 10 Mississippian sections and logs of 2 wells. Plates include 20 photomicrographs of thin sections of Mississippian rocks.--P. Harker.

1-1114. Douglas, R. J. W. GREAT SLAVE AND TROUT RIVER MAP-AREAS, NORTHWEST TERRITORIES: Canada, Geol. Survey, Paper 58-11, 57 p., 3 figs., Maps 27-1958 and 28-1958 (in pocket), scale 1 in. to 3 mi., 1959, 24 refs.

Preliminary account of the geology of some 46,600 sq. mi. around and W. of Great Slave Lake which is part of the area covered by a helicopter-supported reconnaissance. The NE. part of the area is underlain by granitic, sedimentary, and volcanic rocks of Archean and Proterozoic age that combine to form part of the margin of the Canadian Shield. Lapping

unconformably on these rocks is a comparatively thin succession of Ordovician beds in turn unconformably overlain by a complex series of Middle Devonian beds, mainly limestone and dolomite. To the W. these are in turn overlain, probably disconformably, by a series of Upper Devonian beds, mainly shale and limestone. Finally, the Devonian strata are unconformably overlain by Cretaceous shale and sandstone.

The Precambrian rocks in the arm of Great Slave Lake are sliced by NE.-trending faults, some of great displacement. Renewed movement along these faults appears to have displaced the nearby Paleozoic rocks.

The lower formations of the Paleozoic succession form a gently SW.-dipping homocline; the higher formations in the western part of the area swing more nearly W. and dip gently S. The Cretaceous beds are almost flat.

Some of the beds are relatively porous, and under suitable conditions may contain oil or gas. They change facies considerably along strike. Pb and Zn minerals are known to be widespread near Pine Point; extensive deposits of gypsum and salt are exposed in the SE. part of the area. --H. M. A. Rice.

1-1115. Mackay, J. Ross. THE ANDERSON RIVER MAP-AREA, N.W.T.: Canada, Dept. Mines & Tech. Surveys, Geog. Branch, Mem. 5, 137 p., 19 illus., 28 figs., 1958, pub. 1959, 115 refs.

The memoir is essentially a detailed terrain analysis of the Anderson River 8 mi. to 1 in. map sheet of the National Topographic Series of Canada. Chap. 2 contains a discussion of the geology, physiography, glaciation, post-glacial marine submergence and of the geomorphic processes operating in the area. --F. A. Cook.

1-1116. Green, L. H. McQUESTEN LAKE AND SCOUGALE CREEK MAP-AREAS, YUKON TERRITORY: Canada, Geol. Survey, Paper 58-4, 5 p., Maps 8-1958 and 9-1958 (in pocket), scale 1 in. to 1 mi., 1958, 6 refs.

Contains two preliminary maps of contiguous areas just N. of the Mayo mining camp in central Yukon. Together they cover about 520 sq. mi. Much of the area is underlain by a thick assemblage of quartzite, schist, graphitic phyllite, and minor limestone that has been tentatively assigned to the Yukon group and is of Precambrian or early Paleozoic age. Overlying these unconformably, in one place only, are dolomites and calcareous rocks of Ordovician to Devonian age. Both the above map-units have been intruded by many large or small sill-like bodies of greenstone. A small stock of granodiorite occurs in one place, and a few related smaller bodies and sills are present.

The area has had a complex structural history, but the principal feature is a large isoclinal syncline crossing the southern boundary in a southwesterly direction. At least one westerly trending thrust fault has been recognized. Several Ag-Pb-Zn showings have been investigated in the region of the syncline mentioned above. --H. M. A. Rice.

1-1117. Alabama, Geological Survey, and Alabama, University, Dept. of Geology and Geography. GUIDE BOOK TO FIELD TRIPS OF THE SOUTHEASTERN SECTION, GEOLOGICAL SOCIETY OF AMERICA. BIRMINGHAM AREA AND CELEBRATED COASTAL PLAIN FOSSIL LOCALITIES: Alabama, Geol. Survey, Inf. Ser. 13, 76 p., 8 illus., 1958, 15 refs.

The field trip covered 3 physiographic provinces including the southern end of the Appalachian Valley and Ridge province, the Warrior Basin portion of the Appalachian Plateau, and the Gulf Coastal Plain. The major emphasis on the trip was the section from Cambrian to Pennsylvanian age in the Birmingham area. The field leaders and authors of the text part of the field trip are as follows: Field Trip to Birmingham-Montevallo-Centreville: Road Log by Arthur J. Blair, Wiley Rogers and W. Gary Hooks; Field Trip to Adkins Mine and Old Tannehill Furnace: Introduction by Arthur J. Blair, Road Log from Adkins Mine and Tannehill by W. Gary Hooks, Old Tannehill Furnace Trip by Earl L. Hastings and Thomas W. Daniel, Jr.; Field Trip to Celebrated Coastal Plain Fossil Localities by Philip E. LaMoreaux, Lyman D. Toulmin, Jr., and J. G. Newton. --W. B. Jones

1-1118. Seitz, James F. GEOLOGY OF THE GEIKIE INLET AREA, GLACIER BAY, ALASKA: U. S. Geol. Survey, Bull. 1058-C, p. 61-120, 27 illus. (1 in pocket), geol. map scale 1:62,500, March 1959, 15 refs.

The Geikie Inlet area is in the Glacier Bay region of southeastern Alaska, about 100 mi. NW. of the city of Juneau. The area is mountainous, with relief of slightly more than 5,000 ft., and the coastline is deeply indented by fiords and inlets. Most of the western half of the area is covered by glaciers.

Beds of metamorphosed marine sedimentary and volcanic rock constitute about one-third of the bedrock exposed in the area and total 23,000 ft. and possibly more of stratigraphic thickness. Included in this is one sequence 8,000 ft. thick composed mostly of limestone beds with some intercalated beds of shale and volcanic rock in the upper part. The lower part is of relatively pure, gray limestone and contains fossils that have been tentatively identified as belonging somewhere in a Silurian to Permian age range. The bedded rocks also include a sequence, possibly 15,000 ft. thick, composed largely of metamorphosed shale and graywacke beds, but containing large amounts of interbedded limestone and volcanic rock. The shale, which includes calcareous and dolomitic shale, and the graywacke have been metamorphosed to hornfels and granulite and have predominantly granoblastic textures. The most common minerals in these metamorphosed rocks are hornblende and oligoclase or andesine, with the addition of diopside where the composition of the original sediment favored its formation.

Two other bedded rock units, having a thickness of a few hundred feet at the most, are exposed at only 2 localities; they are a bed of conglomerate and a sequence of argillite and graywacke. The rock in both units is relatively unmetamorphosed, which indicates that the 2 units probably are unrelated to the other bedded sequences in the area.

Limestone of the Willoughby limestone formation (probably of Late Silurian age) forms one isolated outcrop within the area, but its relationship to other bedded rock in the area has not been determined. In adjacent areas the Willoughby limestone forms large and conspicuous outcrops that reveal a stratigraphic thickness of more than 5,000 ft.

Bodies of diorite ranging from 25 ft. to 12 mi. in length are distributed through the area; they total about one half of the bedrock exposed. The largest of these, in the western part of the area, is a fairly well-defined elongate northward-trending body. The rest of the diorite is distributed in many smaller and less well-defined masses through parts of the

eastern third of the area.

A notable characteristic of the diorite is the heteorogeneity of its appearance. This heteorogeneity is due to the pronounced irregularity in texture, variety, and abundance of inclusions and the scattered migmatitic zones in the rock. The irregularity of texture is due to variations in the size of constituent mineral grains and the irregular outlines of the larger crystals, which are typically porphyroblastic. This textural irregularity is most pronounced near contacts between diorite and bedded rock where broad irregular zones of gradational types of rock have formed. In many of these places migmatitic rock has formed; the migmatitic rock, which is composed largely of porphyroblastic plagioclase and hornblende, is termed hornblende-plagioclase rock in this report.

Another characteristic of the diorite is planar fabric that is reflected by gneissic banding and oriented inclusions of both bedded rock and fine-grained diorite. The orientation of this fabric follows a generally northward strike and is parallel to the prevailing strike of the bedded rocks in the area. This parallelism is maintained across contacts between diorite and bedded rock regardless of whether the contact is parallel to the bedding or at right angles to it.

These gross features of the diorite, and other smaller scale ones, indicate that the diorite is of metamorphic rather than igneous origin.

Three stocks of granodiorite, ranging from half a square mile to 10 sq. mi. in area, have been intruded into the diorite and bedded rocks in this area. These stocks may probably be correlated with similar bodies that were intruded during the Mesozoic era in other parts of southeastern Alaska.

Within the mapped area the structural trends in the diorite and the bedded rock generally follow a strike ranging from N. to NE. with dips ranging from 60° W. to 60°E. This trend constitutes a divergence from the regional northwestward trend that prevails throughout most of southeastern Alaska, and may possibly be an indication that the Glacier Bay area lies near the margin of the structural province that extends to the SE. Most faults in the area are parallel to the regional trend and strike northwestward; Shag Cove, Tyndall Cove, and Favorite Fiord are conspicuous examples of the expressions of such faults. Most of the other faults in the area are at right angles to this northwesterly trend; among these are the faults that probably determine the position and trend of Geikie Inlet and the gorge of Abyss Lake.

The area is now partly covered by valley glaciers, and within the past 8,000 years has been largely covered several times with ice sheets originating to the N. and W. After each retreat of an ice sheet, forests of hemlock and spruce flourished, only to be overwhelmed and buried by the succeeding ice sheet. Dating of these buried trees by radiocarbon methods has determined the times of each of the ice advances. The most recent advance took place within the last 500 years and the retreat began about 150 years ago. The valley glaciers within the area are all retreating rapidly at present.

No mineral deposits of economic value were found in the area although strong magnetic anomalies in one place suggest the presence of buried magnetite. --Auth.

1-1119. Hall, Clarence A., Jr. GEOLOGY AND PALEONTOLOGY OF THE PLEASANTON AREA, ALAMEDA AND CONTRA COSTA COUNTIES, CALIFORNIA: California, Univ., Pubs. Geol. Sci., v. 34, no. 1, p. 1-90, 2 figs. (in pocket), 5 maps (1 in pocket), 12 pls., 1958, 69 refs.

The Pleasanton area is within the Diablo Range, approximately 30 mi. SE. of the city of Oakland. The area has several NW.-trending ridges separated by valleys, largely bounded by faults. Among the more prominent valleys are the San Ramon, Sunol, and Calaveras. The western part of the Livermore Valley, if not all of it, is also bounded by faults. The Pleasanton area consists of the Niles, Dublin, Livermore, and La Costa Valley quadrangles.

The rocks within the Pleasanton area range in age from Jurassic to Recent. Except for 2 formations, all the rock units have been previously named. A new name, the Niles Canyon formation, is proposed for a thick Lower Cretaceous section. Another new name, the Tolman formation, is proposed for the Eocene rocks.

The Cretaceous rocks consist of the Lower Cretaceous Oakland conglomerate conformably overlain by shale and siltstone beds of the Lower Cretaceous Niles Canyon formation. The youngest Cretaceous rocks are the Del Valle formation of Late Cretaceous age.

The oldest Tertiary rocks in this area are the Eocene Tolman formation. The younger Tertiary formations, which are more extensive, are the Sobrante sandstone, Claremont shale, and Oursan sandstone of middle Miocene age and the Tice shale and Hambre sandstone of lower upper Miocene age. The Briones, Cierbo, and Neroly sandstones are upper upper Miocene. The Orinda formation, Livermore gravels, and Irvington gravels are Pliocene and Pleistocene in age.

The most intensive faulting and folding occurred sometime between the Pliocene and late Pleistocene. Recent movement along the Hayward fault is shown by a variety of rift features. The major faults within the area are the Calaveras-Sunol and Hayward, both of which are right lateral faults.

The significant results of this study are as follows:

1. The Cretaceous rocks W. of the Calaveras-Sunol fault, previously regarded as Early Cretaceous are shown to be in part Late Cretaceous.

2. Rocks previously referred to as the "Chico formation" are now recognized as constituting 2 distinct formations, the Niles Canyon and Del Valle.

3. New evidence shows that the Oakland conglomerate and Niles Canyon formation range in age from Berriasian to Valanginian. The age of the Del Valle formation is established as Cenomanian-Turonian to lower Senonian.

4. For the first time Eocene rocks, here called the Tolman formation, are recognized in this area. The Tolman formation contains abundant fossil algae which were used to date this unit.

5. Middle and upper Miocene rocks, described by A. C. Lawson in the San Francisco Folio, have been traced to the Pleasanton area and farther S. into the San Jose area.

6. Several new molluscan species were discovered.--Auth.

1-1120. Ross, Clyde P., and Richard Rezak. THE ROCKS AND FOSSILS OF GLACIER NATIONAL PARK: THE STORY OF THEIR ORIGIN AND HISTORY: U. S. Geol. Survey, Prof. Paper 294-K, p. 401-439, 26 illus. (3 in pocket), geol. maps scales 1:63,360 and 1:750,000, Apr. 1959, 32 refs.

The story of Glacier National Park begins about 500 million years ago, at a time when there were no mountains in the region - only a vast, exceedingly

shallow sea, bordered by desolate plains. The sand, clay, and mud, in part very limy, that were laid down in this sea eventually hardened into the rocks that are now known as the Belt series. These are the principal rocks in the park. Scattered through these rocks are crinkled, limy masses of many forms, the remains of deposits made by colonies of algae. After the Belt series was laid down successive seas slowly advanced and retreated through long ages across what is now Glacier National Park, burying the Belt rocks under younger ones. After another very long time, a gentle uplift, the forerunner of later events, brought this part of the continent above the reach of sea water for the last time. Much later, some 50 million years ago, the disturbance became far more intense. To climax this upheaval, a mass of rock thousands of feet thick and hundreds of miles long was shoved eastward for 35 mi. or more. This tremendous dislocation, well exposed along the eastern boundary of the park, is known as the Lewis overthrust.

When the rocks of the region emerged from the sea they began to be attacked by erosion. As successive periods of crustal movement and erosion continued, the younger rocks were slowly stripped off the Belt series, and sculpture of the latter by weather and water shaped the early Rocky Mountains.

The final episode in the park's geologic past was the ice age, beginning about a million years ago. Repeated advances and retreats of the great glaciers in the high valleys accentuated the mountain terrain and developed the scenic grandeur that is now Glacier National Park. One may say that the park is still in the ice age, for some glaciers still exist.

The present report, companion to 2 more technical reports on the region, informally presents the story of the park's development through past eras for readers without geologic training. Many places worth visiting are cited in the text, and a shaded relief map is provided to help find them. --Auth.

1-1121. Allen, John E., and Frank E. Kottlowski. ROSWELL-CAPITAN-RUIDOSO AND BOTTOMLESS LAKES PARK, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Scenic Trips to the Geologic Past, no. 3, 47 p., illus., 1958.

1-1122. Govett, Ray. THE GEOLOGY OF THE CABANISS-ARPELAR AREA, PITTSBURG COUNTY, OKLAHOMA: Compass, v. 36, no. 3, p. 138-51, 3 illus., 2 maps, March 1959, 18 refs.

The Cabaniss-Arpelar area is located in NW. Pittsburg County, Oklahoma, in the NW. portion of the old McAlester basin. Six formations of Pennsylvanian Desmoinesian age crop out in the area. These include rocks of part of the Krebs group and all of the Cabaniss group. Rocks of the Krebs group include McAlester, Savanna, and Boggy formations. The Cabaniss group includes the Thurman, Stuart, and Senora formations. The Krebs group reaches a thickness in excess of 2,640 ft., and the Cabaniss group is about 589 ft. thick, giving a total thickness of over 3,200 ft. of sediments at the surface in this area.

Few fossils were found, and most of these were too poorly preserved to be identified. Mesolobus and "Marginifera" were the only invertebrates identified. Other invertebrates included pelecypods, gastropods, and possibly other species of brachiopods. A few plant remains were found, but none of any significance.

Principal structural features include the McAlester anticline, the Talawanda syncline, and the Lipypad Creek anticline. These structures are reflections of the compressive forces that folded and faulted the Ouachita Mountains to the SE. The age of the folding cannot be definitely determined, but in this area it appears to have ended in early Thurman time as beds of the upper part of the Thurman do not seem to be involved in the folding. Little can be added to the history of the basin from the history recorded in this area. During most of the time of deposition there were 2 land masses to the S. and a shallow basin in the area of the deposition. At the end of the Boggy time the sea withdrew at least to the limits of the basin, and when the sea returned at the beginning of Thurman time, renewed uplift to the S. accompanied it.

Two coal outcrops were mapped in this area that had not previously been mapped. One of these is at the base of the lower part of the youngest Boggy shale member, and the other is in the lower part of the Stuart shale. Economic possibilities in this area are not too encouraging at present. Eighteen wells have been drilled in search of oil or gas and only 2 were completed; these have since been abandoned. Coal in the area is thin and poor, and other materials are not suitable for commercial uses. --Auth.

1-1123. Smith, Fred E. LOWER TERTIARY AND UPPER CRETACEOUS OF BRAZOS RIVER VALLEY, TEXAS: 54 p., 6 figs., 8 pls., map, Bryan, Texas, Society of Economic Paleontologists and Mineralogists (Gulf Coast Section) and Houston Geological Society, May 1959, 28 refs.

The Guidebook has data on the outcropping basal middle Eocene, lower Eocene, Paleocene, and Upper Cretaceous. A brief geological history is presented of the section studied. Then follows a route map, scale 1 in. to 2 mi., showing stops and formations exposed. Each of the outcrops visited is illustrated by photographs or sketch profile sections. A columnar section, composited from wells in the area, shows the thickness and electrical log character of the formations, and the approximate stratigraphic position of the stops. An annotated bibliography includes 28 titles.--E. H. Rainwater.

Previous guidebook on the upper and middle Tertiary of the Brazos River valley is listed as GeoScience Abstracts 1-346.

1-1124. Teichert, John A. GEOLOGY OF THE SOUTHERN STANSBURY RANGE, TOOELE COUNTY, UTAH: Utah Geol. & Mineralog. Survey, Bull. 65, 75 p., 14 illus., Apr. 1958.

The Stansbury Mountains consist of a single N.-S.-trending range located W. of Tooele, Utah. Approximately 70 sq. mi. of the Southern Stansbury Mountains were mapped and studied for this report. A section of Paleozoic rocks, in excess of 27,000 ft., is present. This includes 4,800+ ft. of Cambrian (not including several thousand feet of unmeasured Tintic quartzite), 1,600+ ft. of Ordovician, 600+ ft. of Silurian, 600+ ft. of Devonian, 3,400+ ft. of Mississippian (not including 1,200+ ft. of unmeasured Manning Canyon shale), and 14,000+ ft. of Pennsylvanian.

Due to the pre-Mississippian uplift, Ordovician, Silurian, and Devonian rocks are absent in the central part of the range. The basal Mississippian rocks rest unconformably on Cambrian beds. Late Devonian beds, where present, are represented by a coarse conglomerate referred to as the Stansbury conglom-

erate. This formation, which is hundreds of feet thick at the N. end of the range, thins to a few tens of feet at the S. end.

Precambrian, Mesozoic, and Tertiary rocks are not exposed in the area studied. Quaternary deposits include: pre-Lake Bonneville fan gravels, Lake Bonneville beds, creep and glacial deposits, Recent sand dune deposits and alluvium.

Structurally the range consists of a N.-S. anticline. At the S. end following folding, the W. limb was removed by Laramide thrusting. Also during the Laramide period, high angle NW.-SE. normal faulting occurred. Later Basin and Range normal type faults roughly parallel the Laramide faults and fold structures. --Utah Geol. & Mineralog. Survey.

2. GEOMORPHOLOGY

See also: Geologic Maps 1-1088, 1-1093, 1-1099; Areal and Regional Geology 1-1115; Geophysics 1-1198; Sedimentary Petrology 1-1258.

1-1125. Weidick, Anker. FRONTAL VARIATIONS AT UPERNAVIKS ISSTRØM IN THE LAST 100 YEARS: Dansk Geol. Foren., Medd., v. 14, no. 1, p. 52-60, illus. incl. sketch map, Sept. 1958.

In this paper an account is given of the available information concerning the positions of the front of the Upernaviks Isstrøm [West Greenland; 72° 50'-73°N.] from 1949 to 1953. The variations in the area of this outflow are compared with those of the well-known Jakobshavns Isbrae outflow in Disko Bugt [69°N. 52°W.]. Both outflows have, in the last 100 years, lost between 150 and 200 sq. km., which characterize exceptional changes in the inland-ice margin. --Auth.

1-1126. Ives, J. D. GLACIAL GEOMORPHOLOGY OF THE TORNGAT MOUNTAINS, NORTHERN LABRADOR: Geog. Bull. no. 12, p. 47-75, 8 figs., 1958, pub. 1959, 53 refs.

Although absolute dating of late-Pleistocene glaciation cannot be correlated yet with other areas, the author postulates that the Torngat Mountains have experienced 2 recent glaciations separated by an interglacial, the final glaciation, the Koroksoak, being much less extensive than the Torngat glaciation which preceded it. Based on this theory, it is proposed that the initiation of the mountain-top detritus antedated the Koroksoak glaciation, and that the deep, frost-shattered mantle is only to be found in areas which remained ice free throughout that glaciation.

During the final stages of the Koroksoak glaciation the ice thinned and withdrew westwards from the Labrador coast, damming lakes against the higher land to the E. as it did so, and although cirque glaciers and some small valley glaciers were reconstituted at this time, the Torngat area became virtually ice free, long before the disintegration of the main mass of ice which lay to the W. and SW. --F. A. Cook.

1-1127. Wahrhaftig, Clyde, and Allan Cox. ROCK GLACIERS IN THE ALASKA RANGE: Geol. Soc. America, Bull., v. 70, no. 4, p. 383-436, 19 illus. on 6 pls., 16 figs. incl. maps, profiles, diags., graphs, fold. map pl., 9 tables, Apr. 1959, 71 refs.

Field studies and examination of aerial photographs of approximately 200 rock glaciers in the Healy (1:250,000) quadrangle in the central Alaska Range showed that there are 3 types of rock glacier in plan: lobate, in which the length is less than the width (200-3500 ft. long and 300-10,000 ft. wide); tongue-shaped, in which the length is greater than the width (500-5000 ft. long and 200-2500 ft. wide); and spatulate, tongue-shaped but with an enlargement at the front. Lobate rock glaciers line cliffs and cirque walls and probably represent an initial stage; the other two move down valley axes and represent more mature stages.

The rock glaciers are composed of coarse, blocky debris that is cemented by ice a few feet below the surface. The top quarter of the thickness is coarse rubble, below which is coarse rubble mixed with silt, sand, and fine gravel. Fronts of active (moving) rock glaciers are bare of vegetation, are generally at the angle of repose, and make a sharp angle with the upper surface. Fronts of inactive (stationary) rock glaciers are covered with lichens or other vegetation, have gentle slopes, and are rounded at the top. Active rock glaciers average 150 ft. in thickness, inactive rock glaciers, 70 ft.

The upper surface of most rock glaciers is clothed with turf or lichens. Sets of parallel rounded ridges and V-shaped furrows - longitudinal near the heads of some rock glaciers and transverse, bowed downstream, on the lower parts of others - and conical pits, crevasses, and lobes mark the upper surfaces of many rock glaciers.

The upper surface of a rock glacier at the head of Clear Creek moved 2.4 ft. per year between 1949 and 1957, and the front advanced 1.6 ft. per year.

Heights of the upper edges of the talus aprons along the fronts of rock glaciers average 45% of the heights of the fronts. Each of these observations implies that motion is not confined to thin surface layers but is distributed throughout the interiors of the rock glaciers, which in this permafrost region are probably frozen. "Viscosity" has been calculated for rock glaciers at between 10^{14} and 10^{15} poises; for glacial ice it has been estimated at between 10^{12} and 10^{14} poises. Maximum average shear stresses within active rock glaciers range from 1 to 2 bars; these values are much larger than those calculated for solifluction and creep features.

Rock glaciers occur on blocky fracturing rocks which form talus that has large interconnected voids in which ice can accumulate. They are rare on platy or schistose rocks whose talus moves rapidly by solifluction.

The rock glaciers lie in an altitudinal zone about 2000 ft. thick, centered on the lower limit of existing glaciers. Although the firn lines on glaciers rise 1200 ft. in a distance of 25 mi. northward across the Alaska Range, the lower limit of active rock glaciers rises only 800 ft. The firn line on southward-facing glaciers is 2000 ft. higher than that on northward-facing glaciers, yet in any given area southward-facing rock glaciers average only 200 ft. higher than northward-facing rock glaciers. Insulation by the debris cover is believed responsible for the difference in altitudinal ranges between rock glaciers and glaciers.

It is concluded that rock glaciers move as a result of the flow of interstitial ice and that they require for their formation steep cliffs, a near-glacial climate cold enough for the ground to be perennially frozen, and bedrock that is broken by frost action

into coarse blocky debris with large interconnected voids. The longitudinal furrows are thought to result from the accumulation of ice-rich bands in the swales between talus cones at the head of the rock glaciers and the subsequent melting of this ice as the rock glacier moves down-valley. The transverse ridges are thought to result from shearing within the rock glacier that would occur where the thickness increases or the velocity decreases downstream.

An average of 30 ft. of bedrock was removed from source areas to form the present rock glaciers, indicating an average rate of erosion of 1-3 ft. per year when they are active.

The climatic history of the Alaska Range that can be deduced from the presence of active and inactive rock glaciers is: (1) deglaciation following the ice advance of 9000 B. C., leading to the thermal maximum; (2) a cold period, following the thermal maximum, during which the now-inactive rock glaciers formed; (3) a warm period; (4) a cold period, indicated by active rock glaciers, continuing to the present, with climatic amelioration during the last 50 years. The first cold period was somewhat colder and longer than the second. --Auth.

1-1128. Craig, B. G. PINGO IN THE THELON VALLEY, NORTHWEST TERRITORIES; RADIOCARBON AGE AND HISTORICAL SIGNIFICANCE OF THE CONTAINED ORGANIC MATERIAL: Geol. Soc. America, Bull., v. 70, no. 4, p. 509-510, 3 illus., Apr. 1959, 7 refs.

A solitary pingo in Mackenzie District, 2 1/2 mi. N. of Thelon River at 64°19'N. 102°41'W., was examined by the writer in 1955. The dome-shaped hill is about 60 ft. high and 200 ft. in diameter. At the top of the feature, 18 in. of structureless silt overlies 3 ft. of laminated silt with organic remains, largely Ceratophyllum demersum L., and with a pollen assemblage indicating forest cover. The organic material, which requires a warmer climate than that now prevailing, has a radiocarbon age of 5500 + 250 years. Neither the pingo nor the silt of which it is composed show any indication of having been overridden by glacial ice.

It is apparent that the area surrounding the pingo was freed of ice considerably more than 5500 years ago. Age of the organic material coincides with that of the postglacial thermal maximum. Formation of the pingo may be due to marked cooling of climate following this period.

Radiocarbon ages have also been determined for 2 samples of organic material from the Back River and Rankin Inlet at about the same distance from the Keewatin ice divide as the pingo. At both sites the organic material is reported to be overlain by deposits from subsequent glaciation. This is incompatible with the writer's interpretation of material found in the pingo. --A. C. Sangree.

1-1129. Cook, Frank A. TEMPERATURES IN PERMAFROST AT RESOLUTE, N.W.T.: Geog. Bull. no. 12, p. 5-18, 3 graphs, 5 tables, 1958, pub. 1959, 10 refs.

Diurnal, seasonal and long-term variations in permafrost to depths of 650 ft. are discussed. Diurnal variations can be observed to a depth of about 3 ft., seasonal variations to a depth of between 50 and 60 ft. where a time lag of about 8 months exists. Records have not been kept for a long enough period of time for an understanding of long-term variations.

The depth of permafrost at Resolute [Cornwallis Island; 75°15'N. 95°W.] is estimated at approximately 1,280 ft. --Auth.

1-1130. Zeigler, John M. ORIGIN OF THE SEA ISLANDS OF THE SOUTHEASTERN UNITED STATES: Geog. Rev., v. 49, no. 2, p. 222-37, 3 illus., 4 maps, diag., Apr. 1959, refs.; also pub. as: Woods Hole, Mass., Oceanog. Inst., Contr. no. 988.

Three types of islands are recognized along the coasts of South Carolina and Georgia: (1) erosion remnants of the mainland now surrounded by marsh or water, (2) beach ridge islands consisting of either single ridges or groups of ridges, (3) islands of marsh.

Beach ridge islands are marine constructional forms. Major island groups of them such as Ossabaw Island or the islands fringing Cape Romaine were built when sea level dropped during Wisconsin glaciation. Postglacial rise of sea level has flooded areas behind the beach ridge islands, and marshes have formed in the flooded places. The sea has also eroded parts of the older beach ridge island complexes, and the eroded sand has been moved to the island ends where new beach ridges are forming. Some examples of beach ridge islands are: Blackbeard, Ossabaw, Hunting, Fripp, Capers, Bull, and Isle of Palms.

Erosional remnant islands are recognized as remnants of the mainland by (1) sediments similar to the coastal plain sediments, particularly by the presence of clay deposits, (2) evenly bedded deposits, (3) general physiographic outline and appearance, and (4) presence of a few "Carolina Bays." Some examples of erosion remnant islands are: Sapelo, Cumberland, St. Helena, Edisto, Wadmalaw, Johns and James.

A hypothesis of the origin of the long, narrow, marsh-filled valley from Cumberland Island on the S. to Skidaway Island on the N. is consistent with erosion remnants seaward of it. This valley is presumed to be cut in a less-resistant stratum in the coastal plain sediments. It was cut by drainage lines which truncated divides between the major streams during a period of lowered sea level. The present day erosion remnant islands were parts of the divides. --Auth.

1-1131. Northrop, John, Maurice Blaik, and Roberto Frassetto. BATHYMETRY OF THE GIBBS HILL AREA, BERMUDA: Deep-Sea Research, v. 5, p. 290-96, 4 figs. incl. chart, 1959, 22 refs.; also pub. as: Columbia Univ., Hudson Labs., Contr. no. 25.

Precision depth recordings were made S. of Gibbs Hill, Bermuda, along a number of closely spaced sounding tracks. The accuracy of transit navigation and the sounding coverage were considered sufficient to justify correcting the soundings for both sound velocity and slope. The corrected soundings show that a steep sided submarine spur extends SSE. from the shelf break off Gibbs Hill. The spur has a topographic relief of 300 fm. and is about 3 mi. long and 1/2 mi. wide. At the 1000 fm. curve, the feature broadens into a platform that extends another 12 mi. seaward to the 2000 fm. curve. True slopes along the steep portion of the spur are as high as 50°, and the bottom echoes appear to be from a number of highlights causing "crescents" on the record. Where a definite break in slope occurs, the apparent bottom shown on the bathygram is that of a diffraction pattern from an edge, and all points on this crescent migrate to a point, which is the true position of the break in slope. --Auth.

1-1132. Heezen, Bruce C., Marie Tharp, and Maurice Ewing. **THE FLOORS OF THE OCEANS. I. THE NORTH ATLANTIC.** Text to accompany the Physiographic Diagram of the North Atlantic: Geol. Soc. America, Spec. Paper 65, 122 p., 49 figs. incl. charts, profiles, diags., graphs; 30 pls. (11 in pocket) incl. illus., charts, profiles; 3 tables, Apr. 1959, approx. 150 refs.

The physiographic diagram: Atlantic Ocean, Sheet 1, which portrays the North Atlantic between 17° and 50°N., is the first of a projected series of diagrams. The diagram is based on continuous echo-sounding traverses made by research vessels. The relief shown on the profiles was sketched in perspective using the technique introduced by Lobeck. Between sounding profiles the relief is speculative, based on extrapolation of trends noted in the profiles.

The area of the diagram is divided into 3 major phsiographic regions which are in turn subdivided into the following categories of provinces:

CONTINENTAL MARGIN
- Category I
  - Continental Shelf
  - Epicontinental Seas
  - Marginal Plateaus
- Category II
  - Continental Slope
  - Marginal Escarpments
  - Landward Slopes of Trenches
- Category III
  - Continental Rise
  - Marginal Trench-Outer Ridge Complex
  - Marginal Basin-Outer Ridge Complex

OCEAN BASIN FLOOR
- Abyssal Floor
  - Abyssal Plains
  - Abyssal Hills
  - Abyssal Gaps and Mid-Ocean Canyons
- Oceanic Rises
- Seamount Groups

MID-OCEANIC RIDGE
- Crest Provinces
  - Rift Valley
  - Rift Mountains
  - High Fractured Plateau
- Flank Provinces
  - Upper Step
  - Middle Step
  - Lower Step

Each province is defined, briefly described, and illustrated with profiles and photographs of echo-sounding records.

The boundaries of the physiographic provinces, defined solely by bottom topography, show good correlation with variations in crustal structure as determined by seismic-refraction measurements and with anomalies of the gravity and magnetic fields. In addition, the province boundaries correlate well with distribution patterns of bottom sediments. The physiographic provinces are thus really morphotectonic provinces. The precise correlation of topographic provinces and structure observed in specific sections can thus be extrapolated along province boundaries to deduce the geology in large areas where no geophysical work has been done. The tectonic map of the Atlantic prepared in this manner will be presented in a subsequent publication. --Auth.

1-1133. James, Preston E. **THE GEOMORPHOLOGY OF EASTERN BRAZIL AS INTERPRETED BY LESTER C. KING:** Geog. Rev., v. 49, no. 2, p. 240-46, map, 2 diags., Apr. 1959, 7 refs.

Lester C. King finds support for his theory of landform evolution in the terrain of eastern Brazil. Four major erosion cycles are identified, and the beginnings of a fifth cycle. The oldest, or Gondwana surface is early Cretaceous. The post-Gondwana surface is still gnawing at the last remaining edges of the Gondwana. It was initiated in the late Cretaceous. The surface now most widely preserved is the early Tertiary Sul-Americana, but its edges are also being attacked by the Velhas cycle. The Paraguaçú cycle has been initiated by recent tilting along the coast line. Each cycle is interpreted in terms of isostatic readjustment to the removal of the older surfaces. Uplift has been in the form of an arch along the axis of the Serra do Espinhaço. But the axis of the latest (Paraguaçu) uplift has shifted to the W. The São Francisco valley is interpreted as a rift, downfaulted along the axis of the arch - similar in origin to the great rift valley of Africa. --Auth.

3. STRUCTURAL GEOLOGY

See also: Geologic Maps 1-1072, 1-1097; Geomorphology 1-1132; Stratigraphy 1-1142; Geophysics 1-1188, 1-1189, 1-1197; Mineral Deposits 1-1292; Fuels 1-1298.

1-1134. King, Philip B. **THE EVOLUTION OF NORTH AMERICA:** 190 p., 96 figs. incl. geol. maps, diags., secs., fold pl. (map), Princeton, New Jersey, Princeton University Press, 1959, refs.

The evolution of North America through geologic time is demonstrated in 9 chapters, each of which discusses a region or regions that epitomize a phase of continental development. Most of the regions selected are in the United States or southern Canada, where more data are available than elsewhere. Although the viewpoint is primarily geological, much use is made of geophysical and geochemical data, especially in regard to deeper crustal layers, and to absolute rock ages.

North America is interpreted as a relatively symmetrical continent, with a central Canadian Shield, that was formed from mobile belts in Precambrian time, and later stabilized. The Shield is bordered on the S. and W. by Interior Lowlands, in which the Precambrian is covered by younger rocks that have not been much deformed. Nearly surrounding the Shield and Lowlands are mountain belts, once mobile, whose rocks were much deformed. To the SE. and S. these are separated from the ocean basins by broad coastal plains and continental shelves.

Evolution of the continent is thought to have been by gradual accretion, beginning at nuclei in the present shield, and proceeding outward, by formation of marginal geosynclines, and by their consolidation by deformation and granitization. It is suggested that the coastal plains and continental shelves may be modern analogues of geosynclines, in early stages of development.

The mountain belts SE. and W. of the Shield and Lowlands are discussed at length. Mountain belts on the N., in Greenland, the Arctic Islands, and Alaska, are mentioned only briefly, and mountain

belts on the S. in Central America and the West Indies, are discussed only insofar as they illustrate broad principles.

The cross-section and the growth during Paleozoic time of the Appalachian and related systems on the SE. are analyzed in detail, as these systems are an ideal example of a mountain belt.

The systems on the SE. are then compared with the Cordilleran system on the W., whose growth continued through Mesozoic and later time. Many features are similar, but there are many novelties and complications. A novel element is the Eastern Ranges and Plateaus (Central and Southern Rocky Mountains and Colorado Plateau), which lie inland from the Cordilleran geosynclinal area, and which were deformed and made mountainous by reactivation of a part of the continent that had once been stabilized. Moreover, in the western part of the Cordillera, the fundamental mountain structure was much modified after the main deformation. The final chapter therefore deals with features that formed in Cenozoic time, and are still forming, in the Basin and Range province, the volcanic province of the Northwestern States, and the Coast Ranges of California. --Auth.

1-1135. Mertie, John B., Jr. CLASSIFICATION, DELINEATION AND MEASUREMENT OF NON-PARALLEL FOLDS: U. S. Geol. Survey, Prof. Paper 314-E, p. 91-124, 12 illus., Apr. 1959, 11 refs.

Simple folds are divided primarily into 2 classes, cylindrical and noncylindrical. The true nature of the stratigraphic surfaces of all folds is unknown, but it is the thesis of this paper that they may be described approximately as cylinders and quadrics. The traces of the stratigraphic surfaces are likewise unknown, but they are represented empirically in selected profiles by algebraic curves. Cylindrical and non-cylindrical folds are divided into 4 genera that depend upon the character of their stratigraphic traces. These are designated as parallel, similar, cognate, and composite folds.

All cylindrical folds have axial lines. They are subdivided into species according to whether the fold has an axial plane or a curved axial surface. Cylindrical parallel folds are unique in that they necessarily have axial planes. Cylindrical similar folds are simply defined as those whose traces, in a plane normal to the axial line, are curves that are reproducible from one another by nondistortional enlargement or reduction. Similar traces are illustrated by elliptic arcs of the same eccentricity, at the same or different scales. Cylindrical cognate folds are defined as those whose traces, in the selected profile are nonparallel nonsimilar curves that are analytically related but differ in the values of their assigned parameters. Cognate traces are represented by ellipses with different eccentricities. Cylindrical composite folds are of 3 kinds. One has related but mixed stratigraphic traces; a second consists of hybrid traces, illustrated by quarter ellipses, either similarly placed or rotated 90° to one another, that are joined where their tangents are parallel; and a third has analytically unrelated traces.

Noncylindrical folds are defined to include quaquaversal folds, elongate or canoe-shaped domes, and the plunging ends of cylindrical folds. All such structures are characterized by an absence of axial lines, though they have analogous indices that are described as apical lines. Canoe-shaped folds have principal sections that are comparable to the axial planes and surfaces of cylindrical folds and to the cross sections normal thereto. The apical lines are either plane or space curves; the principal sections may be either plane or curved surfaces. Plunging folds have some of the characteristics of canoe-shaped folds. The stratigraphic surfaces of noncylindrical folds are illustrated by spheroids, ellipsoids, and modifications thereof. The traces of the stratigraphic surfaces in the principal sections are analogous to those in the selected profiles of cylindrical folds.

Parallel folds, both cylindrical and noncylindrical, are represented in cross section by higher plane curves that may be precisely generated by means of evolutes and involutes. All nonparallel folds, however, must be shown approximately in cross section by empirical curves. Ellipses were chosen for this purpose, first, because they are simple curves of the second degree; second, because their eccentricities are variable; third, because the arcs of an ellipse at the ends of its major and minor axes are parallel, and this permits the delineation of dips at 90° at the base of a fold; and finally, because this parallelism facilitates the construction of hydridized traces. The empirical curves thus generated by the use of ellipses are extensively modified by variations in the eccentricity, by change of scale, and by several types of linear translation, to simulate the various kinds of nonparallel folds that are required to fit the geological data.

Many ellipses of different eccentricity and scale are needed in the empirical representation of nonparallel folds. These are generated as glissettes, by application of the trammel of Archimedes, the construction and use of which are described. As a further aid, 38 prolate and oblate ellipses of different eccentricity are illustrated.

Stratigraphic thickness, in the selected profiles, is defined as the area between 2 elliptic traces, divided by the length of a medial elliptic arc. The area between the elliptic arcs is obtained either by graphical integration or by formula. The length of an elliptic arc requires an evaluation of Legendre's E function, as given in a table of elliptic functions. Graphic linear integration may also be used. As an aid in this work, the lengths of 99 semiellipses, with major semiaxes of 10, and minor semiaxes ranging from 9.9 to 0.1 have been computed and tabulated. This table, with a trivial amount of interpolation, gives the semiperimeters of all ellipses, regardless of the lengths of their semiaxes. An empirical formula for the length of an ellipse is also presented.

Methods for the mathematical analyses of the traces of cylindrical and noncylindrical folds are not treated at length in this paper, but the value of such work is stressed. Some elementary methods are outlined, and attention is called to the applicability of intrinsic equations for the simplification of such work. --Auth.

1-1136. Muehlberger, William R. INTERNAL STRUCTURE OF THE GRAND SALINE SALT DOME, VAN ZANDT COUNTY, TEXAS: Texas, Univ., Bur. Econ. Geology, Rept. Inv., no. 38, 24 p., 2 figs., 6 pls. incl. map (in pocket), March 1959, 6 refs.

Since 1947, the Morton Salt Company's Kleer mine in the Grand Saline salt dome has more than doubled in size. Balk's mapping of the salt structures in the pre-1947 workings showed that: (1) the layers of salt near the southeastern border of the dome dip steeply SE and S., presumably parallel with the dome border; elsewhere the layers form intricate systems of folds;

(2) the axes of all folds plunge nearly vertically; (3) anhydrite and halite are elongated parallel to the nearest fold axis; (4) the absence of any fractures, faults, crosscutting salt layers, foreign inclusions, and brine indicates an undisturbed evolution of the deformation structure in a nearly homogeneous, layered salt mass.

The present study includes the new workings and contains a composite map of Balk's study and this one. In addition to confirming Balk's conclusions, this study demonstrates that: (1) the structure of this dome is not symmetrical; consequently, this dome probably rose as a series of spines; (2) radical changes in strike of the trace of the axial planes at the mine levels occur along E.-trending planes, which possibly represent zones of failure in the overburden; (3) attenuation of folds is observed as the perimeter of the dome is approached; (4) beds of giant salt crystals exhibit cleavage faces several feet on a side. --Auth.

1-1137. Nickelsen, Richard P., and Gerardo W. Gross. PETROFABRIC STUDY OF CONESTOGA LIMESTONE FROM HANOVER, PENNSYLVANIA: Am. Jour. Sci., v. 257, no. 4, p. 276-86, 14 figs., table, Apr. 1959, 15 refs.

The study applies established techniques of calcite petrofabric analysis to a low-grade metamorphic, sandy-textured, carbonate rock. Prominent features of the fabric are overall monoclinic symmetry, post-crystalline late phase orthorhombic symmetry, and ac girdles perpendicular to megascopic fold axes. The fabric results from differently oriented episodes of orthorhombic movement the axes of which rotated through the rock during deformation. Compression axes causing late phase deformation are in the ac plane in zones approximately bisected by the normal to slaty cleavage. --Auth.

1-1138. Bascom, Willard. THE MOHOLE: Sci. American, v. 200, no. 4, p. 41-49, illus., chart, sec., Apr. 1959.

The AMSOC Committee of the National Academy of Sciences is conducting a study of the feasibility of drilling a hole completely through the earth's crust to sample the earth's mantle. Since the boundary between the crust and the mantle is defined by an abrupt change in the velocity of seismic waves which was first discovered by Professor A. Mohorovičić, that boundary has become known as the Moho. Thus a hole to the mantle is a mohole.

The crust of the earth is much thinner beneath the oceans than beneath the continents, the average thickness of the two being, respectively, about 12 km. and 32 km. So the hole will be drilled at sea. Under an oceanic island the depth to the Moho is greater and the geologic situation perhaps anomalous. Besides, a complete record of the layers beneath the ocean floor is wanted.

The principal objective of the mohole is to obtain a continuous oriented core through the sediments and the crustal layers into the mantle so that complete chemical and physical analyses of the rocks be made including mineral composition, radioactive content, density, and thermal and electrical conductivity. These will enhance the value of the indirect measurements that have already been made.

The sediments will be examined closely for fossils from ages for which there is no land record. Possibly there will be hints as to the earth's early ocean and atmosphere, its magnetic field, and the nature of the primordial surface.

It is believed that the drilling of such a hole is within the reach of man's technology today. The first, relatively shallow holes can be made by converting existing floating oil drilling platforms such as the CUSS 1 for work in the deep sea. Then, when design data are available, a drilling outfit will be assembled which can reach to the mantle--a depth of over 30,000 ft.--Auth.

1-1139. Spencer, Edgar Winston. GEOLOGIC EVOLUTION OF THE BEARTOOTH MOUNTAINS, MONTANA AND WYOMING. Part 2. FRACTURE PATTERNS: Geol. Soc. America, Bull., v. 70, no. 4, p. 467-508, 4 illus. on 2 pls., fold. map pl., 20 figs. incl. maps, diags., graphs, 6 tables, Apr. 1959, 51 refs.

The Beartooth uplift is a large elongate (N. 65° W.) range located along the Montana-Wyoming border. The warped Precambrian peneplaned surface is an asymmetric anticlinal fold. Differential uplift of the basement amounting to more than 15,000 ft. is greatest along the northern side of the crest. Along the northern and eastern borders of the uplift the crystalline rocks are thrust over Mesozoic sediments. Magnitude of thrusting is variable and is at least 10,000 ft. at the northeastern corner where tears have developed in the thrust. The northeastern slope is dissected by glaciation and divided into large valleys and plateaus. The southwestern slope has a relatively uniformly inclined surface. Relief is more than 7000 ft. on the northern slope and about 2000 ft. on the southwestern slope.

Folded granitic gneisses and migmatites are exposed in the core of the range. The folds trend N.-S. to N. 20° E. and plunge southward. Rocks throughout the uplift are complexly fractured. Fracture studies over 700 sq. mi. of the uplift include more than 25,000 fracture measurements made at 250 stations, located to give coverage of all parts of the uplift. The nature of fracturing is considered for the uplift as a whole, for subdivisions of the uplift, and at individual stations. A regional fracture pattern consists of 4 prominent trends: N. 15° W., N. 45° W., N. 45° E., and N. 65° W. Other trends are at N. 55°-60°E., N. 15°-20°E., N.-S. to N. 5°E., and N. 85° E. to E.-W. All these fractures are nearly vertical. The pattern is consistent and best developed on the southwestern slope. Low-dipping fractures occur in the northeastern part of the uplift and result from more intense deformation in the overthrust parts of the uplift. The inclined fractures do not form a consistent pattern.

Dikes and large fracture zones are shown on aerial photographs of the southwestern slope of the uplift. Fracture trends on photographs have been studied in detail. Photographs alone are not adequate for studies of fracture patterns, but ground measurements can be correlated with photo lineaments.

Five groups of dikes are found in the uplift; all have trends parallel to fractures: (1) ortho-amphibolite dikes which may be pregranitization are the oldest dikes; (2) Archean metabasaltic dikes, somewhat younger; (3) unmetamorphosed late Precambrian quartz dolerites. The cycle of metamorphism and granitization is dated at 2.7 billion years; (4) olivine dolerite dikes, probably Tertiary; (5) Laramide porphyry dikes. Dikes of different ages occupy the same fracture trends; hence the dikes cannot be used to differentiate the fracture patterns. The dikes show that the fracture patterns are Archean.

The major fracture trends indicate that the pattern

was formed by warping with relative shortening along the NW. trend, resulting in 2 sets of tension fractures parallel and perpendicular to maximum shortening. Two sets of conjugate shears also formed at angles of 25°-30° with the direction of maximum shortening. Other fractures appear to have formed in a later deformation when the areas outlined by early major fracture zones were deformed as blocks. These fractures formed with reference to maximum shortening of the blocklike masses. Movements in the core of the uplift in the Laramian were again governed by the pre-existing fractures. --Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 1-1113, 1-1123; Geomorphology 1-1128; Structural Geology 1-1134; Paleontology 1-1158, 1-1169, 1-1176; Geochemistry 1-1220; Sedimentary Petrology 1-1259, 1-1260, 1-1261; Fuels 1-1301, 1-1302, 1-1303.

1-1140. Interdepartmental Stratigraphic Committee. U.S.S.R. STRATIGRAPHIC CLASSIFICATION AND TERMINOLOGY.[1] Translated by John Rodgers: Internat. Geology Rev., v. 1, no. 2, p. 22-38, Feb. 1959, 3 refs.

Stratigraphic subdivisions should be objective categories reflecting steps in the geological development of the earth as a whole or of its separate regions. Basic for distinguishing subdivisions of stratigraphic and geochronologic scales appear to be criteria reflecting the character and scale of the following closely interconnected phenomena: 1) tectonic movements of wide geographic range, 2) paleogeographic changes, 3) changes in the process of sedimentation and denudation, 4) manifestations of igneous activity and processes of metamorphism, and 5) organic evolution.

Soviet geologists consider that the unified stratigraphic scale should comprise the following units as accepted by the VIIIth International Geological Congress in 1900:

Stratigraphic Subdivisions
- Gruppa - Group
- Sistema - System
- Otdel - Division
- Yarus - Stage
- Zona - Zone

Geochronologic Subdivisions
- Era - Era
- Period - Period
- Epokha - Epoch
- Vek - Age
- Vremya - Time.

For areas of geologic complexity which cannot be assigned to units of the designated unified stratigraphic scale, the following auxiliary regional subdivisions can be used for practical purposes such as mapping, etc.:
- Seriya - Series
- Svita - Suite
- Podsvita - Subsuite
- Pachka - Packet

Each of the subdivisions in the unified stratigraphic scale and each of the auxiliary regional subdivisions are defined and briefly discussed. Special criteria are given for classification of igneous formations and the Precambrian. --G. E. Denegar.

[1] Stratigraficheskaya Klassifikatsiya i Terminologiya: State Scientific-Technical Publishing House for Literature on Geology and Mineral Resources, Moscow, 1956.

1-1141. Driscoll, Egbert G. EVIDENCE OF TRANSGRESSIVE-REGRESSIVE CAMBRIAN SANDSTONES BORDERING LAKE SUPERIOR: Jour. Sed. Petrology, v. 29, no. 1, p. 5-15, 5 figs., 6 tables, March 1959, 9 refs.

The Upper Cambrian Munising sandstone bordering the southern shore of Lake Superior is divided into 3 members: the basal conglomerate, Chapel Rock member, and Miner's Castle member. Heavy mineral similarities indicate that the Chapel Rock member may be correlated with the Dresbach of Wisconsin. The Miner's Castle member disconformably overlies the Chapel Rock member. Variations in sorting and mean grain diameter through the Miner's Castle member indicate transgressive and regressive depositional environments. Variations in the heavy mineral suite, particularly in garnet content, indicates that the Miner's Castle member is transitional between the transgressive Franconia sandstone and the regressive Jordan sandstone. --Auth.

1-1142. Hyde, David E. A STRUCTURAL AND STRATIGRAPHIC STUDY OF THE FAIRVIEW-McMILLAN FORMATIONAL CONTACT IN THE CINCINNATI AREA: Compass, v. 36, no. 3, p. 161-71, 4 figs. incl. 2 maps, March 1959, 14 refs.

A detailed study was made of the Fairview-McMillan contact in the Cincinnatian series [Upper Ordovician] in an area of approximately 600 sq. mi. in Hamilton County and adjacent parts of Clermont, Warren, and Butler counties, Ohio, and Dearborn County, Indiana; and the northern parts of Boone, Campbell, and Kenton counties, Kentucky. This area is astride the broad belt of relative uplift of the Cincinnati arch. It is shown that the Fairmont-Bellevue contact is transitional, both from lithologic and paleontologic lines of evidence. The writer has selected the lower surface of the layer at the base of the "lower massive" bed in which Bellevue fossils first appear as the operational contact of the Fairview and McMillan formations. This horizon coincides with the inferred selection of the formational contact by Nickles, Ulrich and Bassler, Foerste, and Braun.

The study indicates that the component of regional dip to the N. is as great, if not greater than the component of dip to the W. in Hamilton County. Unless there is a sharp rise in the strata E. of the area studied, the Cincinnati arch may be defined as an exceedingly low and broad regional structure in southwestern Ohio. No direct evidence was found in this study proving that the Wabash arch exists in the area under investigation. A persistent NW.-SW. anticlinal trend in the center of Hamilton County may in reality be the southern extension of the Wabash arch. --Auth.

1-1143. Sutherland, P. K. CARBONIFEROUS STRATIGRAPHY AND RUGOSE CORAL FAUNAS OF NORTHEASTERN BRITISH COLUMBIA: Canada, Geol. Survey, Mem. 295, 177 p., 4 figs. (incl. map and secs. in pocket), 33 pls. (30 illustrating fossils), 1958, 128 refs.

Marine strata of Carboniferous age were laid down throughout the Rocky Mountain region and extend

northwards through northeastern British Columbia into Yukon. They have hitherto been studied in detail only in the vicinities of Banff and Jasper where they have been assigned to the Banff, Rundle, and Rocky Mountain formations. Field work for this report shows that the Alberta rock subdivisions can be used as far north as the Kakwa-Jarvis lakes area of British Columbia. North of Peace River a new formation, the Prophet formation, overlying an unnamed basal shale unit is applied to limestones of Kinderhook to Meramec age. Overlying beds are of Triassic age. In the Tetsa-Alaska Highway region the Kindle formation of Laudon and Chronic is restricted to exclude an upper unnamed chert unit of late Carboniferous or Permian age. Rugose corals are used to offer some means of correlating the Carboniferous rocks. Systematic descriptions of 37 species of 14 genera from the families Hapsiphyllidae, Caniniidae, Syringaxonidae, Clisiophyllidae, Hallidae, and Lithostrotionidae include many new species. --P. Harker.

1-1144. Ham, William E. STRATIGRAPHY OF THE BLAINE FORMATION IN BECKHAM COUNTY, OKLAHOMA: Oklahoma Acad. Sci., Proc., v. 38, p. 88-93, 2 figs., 1958, 8 refs.

Field work in southwestern Oklahoma, chiefly in the excellent exposures of southern Beckham County, demonstrates that the concept of middle Permian evaporite beds in the Blaine formation must be changed from that given in earlier published reports. As shown from measured stratigraphic sections, the formation has a maximum thickness of 200 ft., its greatest in Oklahoma, and includes at the top an 85-ft. sequence of gypsum which was previously unrecognized.

In the new classification, the Blaine formation contains all the thick gypsum beds of early Guadalupean(?) age on the outcrop in southwestern Oklahoma. It consists of 4 members of nearly pure gypsum (descending: Van Vacter, Collingsworth, Cedartop, and Haystack), 5 thin beds of dolomite, and 3 beds of reddish-brown and grayish-green shale which separate the evaporite beds into cyclic units.

Where fully represented the Blaine formation ranges in thickness from 130 to 200 ft., of which about 75% is massive gypsum. The formation thickens westward, mainly by addition of gypsum at the top, and it disappears eastward by gradation into shale and cross-bedded deltaic sandstone. --Auth.

1-1145. Robinson, Florence M. TEST WELLS, SIMPSON AREA, ALASKA. With a section on core analyses, by S. T. Yuster: U. S. Geol. Survey, Prof. Paper 305-J, p. 523-68, 9 illus. (3 in pocket), 4 tables, Apr. 1959, 10 refs.

Two test wells were drilled in the Cape Simpson area, northern Alaska, as a part of the exploration of Naval Petroleum Reserve No. 4. The first well, Simpson test well 1, was located and drilled in late 1947 and early 1948 on a deep seismic prospect near shallow core tests which had showed some signs of oil. The well was drilled to a depth of 7,002 ft., penetrating rocks of Cretaceous, Jurassic, Triassic, and pre-Mesozoic age. Fair shows of oil were found in the Cretaceous Grandstand formation, but they were not of commercial value, and the well was abandoned. The test however, furnished a great deal of stratigraphic information.

North Simpson test well 1 was drilled in the spring of 1950 to test another seismic anomaly. The well proved to be dry. North Simpson test well 1 penetrated Upper and Lower Cretaceous rocks to a total depth of 3,774 ft. but no sandstones or other suitable reservoir rocks were found. --Auth.

1-1146. Robinson, Florence M. TEST WELLS, TITALUK AND KNIFEBLADE AREAS, ALASKA. With micropaleontologic study of test wells in the Titaluk and Knifeblade areas, northern Alaska: U. S. Geol. Survey, Prof. Paper 305-G, p. 377-422, 9 illus., Apr. 1959, 5 refs.

The Titaluk and Knifeblade test wells were drilled in 1951 as a part of the exploration program of Naval Petroleum Reserve No. 4 in northern Alaska. Titaluk test well 1, which is 62 mi. W. of Umiat, was drilled to a depth of 4,020 ft. Knifeblade test wells 1, 2, and 2A, which are about 68 mi. WSW. of Umiat, were drilled to depths of 1,805 ft., 373 ft., and 1,805 ft. respectively. These wells were drilled on 2 different anticlines to test sandstone of the Grandstand formation of Cretaceous age (the principal oil and gas producing strata in the Umiat field, Alaska). Except for the few minor shows of gas and oil, the tests were dry.

This report includes lithologic descriptions, paleontologic determinations, and engineering and logistic information obtained in the drilling of these tests. Some of the data are presented graphically. --Auth.

1-1147. Collins, Florence Rucker. TEST WELLS, SQUARE LAKE AND WOLF CREEK AREAS, ALASKA U. S. Geol. Survey, Prof. Paper 305-H, p. 423-84, 8 illus. (2 in pocket), Apr. 1959, 10 refs.

Square Lake test well 1 and Wolf Creek test wells 1, 2, and 3 were drilled on 2 anticlines in the Arctic foothills province of northern Alaska. The wells were drilled in 1951 and 1952 as part of the U. S. Navy's program of exploration for oil in Naval Petroleum Reserve No. 4. Rocks of Cretaceous age were penetrated in both anticlines. Some of the sands penetrated were found to contain small noncommercial amounts of gas and oil, and the wells were abandoned. This report includes geologic, paleontologic, logistic, and engineering data obtained in drilling the tests; graphic logs are included to supplement the text. --Auth.

1-1148. Lozo, Frank E. STRATIGRAPHIC RELATIONS OF THE EDWARDS LIMESTONE AND ASSOCIATED FORMATIONS IN NORTH-CENTRAL TEXAS (In: Symposium on Edwards Limestone in Central Texas): Texas, Univ., Pub. 5905, p. 1-19, 10 figs., March 1959, 29 refs.

Salient stratigraphic relationships of the mid-Comanche Cretaceous formations in N.-central Texas are analyzed with reference to regional genetic and diastrophic factors. Based on historically significant outcrop sections in this classic area of Cretaceous investigations, a southern complex of the Edwards, Comanche Peak, and Walnut formations is indicated to pass northward into a complex composed of the Goodland, Walnut, and Paluxy formations. Classification of the included stratigraphic interval as the "Fredericksburg division" follows R. T. Hill's early nomenclature and concept of an integrated subseries representing a major and distinct cycle of sedimentation. --Auth.

1-1149. Nelson, Henry F. DEPOSITION AND ALTERATION OF THE EDWARDS LIMESTONE,

CENTRAL TEXAS (In: Symposium on Edwards Limestone in Central Texas): Texas, Univ., Pub. 5905, p. 21-95, 8 figs., 30 pls. incl. 3 maps (in pocket), secs., March 1959, 51 refs.

In Bell, Coryell, and McLennan counties, Texas, the Edwards formation is a reef complex of rudistid bioherms and biostromes that grade laterally into well-bedded inter-reef deposits. The bioherms are composed of a mass of rudistids and associated organisms in a very fine-grained matrix. Three faunal zones may be recognized: a basal Cladophyllia zone grading upward into a Toucasia and Monopleura zone which grades upward and outward into a Caprinuloidea, Eoradiolites, and Chondrodonta zone. Maximum thickness of the bioherms is 55 ft. The reef cores grade laterally into fragmental flank beds.

The inter-reef sediments consist of calcilutites, calcarenites, and shell debris. Particles are well rounded and are cemented with originally precipitated calcite. Primary and diagenetic dolomite are present. Inter-reef chert is a primary deposit.

The Kiamichi and Duck Creek formations unconformably overlie the Edwards formation. South of the pinch-out of the Kiamichi formation, the Edwards formation has been altered by postlithification solution, recrystallization, cavity-filling, dolomitization, and silicification.

During Fredericksburg time a reef complex formed along the W. side of the Tyler basin and subdivided the lagoon behind the main reef trend to the S. into 2 parts: the Austin lagoon in which the Edwards formation was deposited and the Tyler lagoon in which the Paluxy, Walnut, and Comanche Peak formations were deposited. The Fredericksburg age was brought to a close by regional uplift, prior to which reef growth had ceased, and inter-reef basins had been filled to the crests of the reefs. --P. U. Rodda.

1-1150. Young, Keith. EDWARDS FOSSILS AS DEPTH INDICATORS (In: Symposium on Edwards Limestone in Central Texas): Texas, Univ., Pub. 5905, p. 97-104, 3 figs., 2 pls., March 1959, 16 refs.

The Edwards limestone is 20 to 25 ft. thick along the Brazos River in Hill and Bosque counties, Texas, where it constitutes a single tabular reef. Biologically it consist of 4 zones which are related to bottom depth at the time of their deposition. The Cladophyllia zone is at the base; this small coral grew in about 20 to 25 ft. of water. Then in ascending order are the Monopleura-Toucasia, the Caprinuloidea zone, and the Eoradiolites-Chondrodonta zone. The top of the Eoradiolites-Chondrodonta zone is thought to have occupied a depth slightly above that of mean low spring tide.

To the NE. this Edwards limestone tabular reef interfingers with the Goodland formation, and to the SW. it is cut out by erosion. The SW. front of the tabular reef was to windward and the NE. to leeward. --Auth.

1-1151. Shelburne, Orville B. A STRATIGRAPHIC STUDY OF THE KIAMICHI FORMATION IN CENTRAL TEXAS (In: Symposium on Edwards Limestone in Central Texas): Texas, Univ., Pub. 5905, p. 105-130, 2 figs., 6 pls. incl. correlation charts (in pocket), secs., March 1959, 19 refs.

Twenty stratigraphic sections of the Lower Cretaceous Kiamichi formation were measured and described from surface exposures in the southern Fort Worth Prairie in Hill, Bosque, Coryell, McLennan, and Bell counties, Texas.

The Kiamichi formation is composed of silty shale, nodular limestone, calcareous clay, and Gryphaea beds. The Kiamichi shale is the uppermost formation in the Fredericksburg group and is enclosed by the Edwards limestone below and the Georgetown limestone above. The Kiamichi is 25 ft. thick near Blum in Hill County. It thins southward along the outcrop and disappears in southern McLennan County.

Corrosion, pitting, and burrowing, and presence of an iron oxide zone at the top of the Edwards formation indicate that the Edwards-Kiamichi contact is unconformable. The characteristic megafossils of southern outcrops, where the Kiamichi is thin, are Gryphaea navia, Exogyra plexa, and Heteraster adkinsi. This fauna is characteristic of the upper Kiamichi of northern outcrops, where the formation is thick. The lower part of thick sections of the Kiamichi is characterized by Gryphaea mucronata, Exogyra texana, and Cyprimeria texana. This distribution suggests that the formation thins from the bottom and that it onlaps the unconformable surface at the top of the Edwards limestone affecting regional thinning to the S.

Local variations in thickness of the Kiamichi are a result of the topography at the top of the underlying Edwards formation during Kiamichi time. Thinner and more calcareous sediments were deposited over the topographically high reef facies of the Edwards limestone. --Auth.

1-1152. Merriam, Daniel F., William R. Atkinson, Paul C. Franks, Norman Plummer, and F. W. Preston. DESCRIPTION OF A DAKOTA (CRETACEOUS) CORE FROM CHEYENNE COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 134, pt. 1, p. 1-104, 13 figs., 4 pls., 11 tables, Apr. 1959, 40 refs.

A Dakota (Cretaceous) core from the Guy F. Atkinson No. 1 Beaumeister well in sec. 31, T. 2 S., R. 39 W., Cheyenne County, Kansas, is described in detail. The 487-ft. cored section extends from the lower part of the Graneros shale almost completely through the Dakota group into the Cheyenne sandstone. Lithologic descriptions are presented, as well as data on fossils, porosity and permeability, clay mineralogy, and other pertinent information. --Auth.

1-1153. Connell, James F. L. THE JACKSON GROUP OF GEORGIA, A PRELIMINARY REPORT: Southwestern Louisiana Jour., v. 2, no. 4, p. 321-347, Oct. 1958.

The Jackson group [Eocene] of Georgia consists of 2 formations, the Ocala limestone and the Barnwell sands and clays. The Ocala limestone crops out from Seminole County, northeastward to northern Dooly County, where its lower portion, the Tivola member, continues northeastward as a tongue or wedge into the lower part of the Barnwell formation. The Barnwell formation crops out from central Sumter County northeastward to the Savannah River.

The Ocala limestone of Georgia is the upper part of the formation known in Florida as the Ocala "restricted" or Crystal River formation. The principal area of outcrop of the Ocala in Georgia occurs between the Flint and Chattahoochee rivers, where the strata consist of white to cream-colored to pink, soft to hard, in places silicified, fossiliferous lime-

stone, containing a prolific fauna of upper Jackson age.

The Tivola member consist of soft, extremely fossiliferous, white to cream-colored limestone, with a buff-colored sand in its lower portion. The Tivola member underlies the Twiggs clay member of the Barnwell formation from northern Dooly County, northeastward to south of Gordon, Wilkinson County.

The Twiggs clay member consists of fuller's earth type clay, cropping out from Sumter County to the Savannah River. In E.-central Georgia, the Twiggs clay member is overlain by red to white sands of the Irwinton sand member of the Barnwell formation. At a few localities the Irwinton sand member is overlain by coarse, red sand and beach pebbles, referred to as the Upper Sand member.

In Washington County, a much localized unit, known as the Sandersville limestone member of the Barnwell formation, lies at or near the upper part of the Irwinton sand member, and contains faunules characteristic of the Tivola member to the S. Stratigraphically younger Barnwell strata above the Upper Sand and Irwinton sand members occur in central and northeasternmost Georgia, and in South Carolina.

The Ocala and Barnwell formations are contemporaneous deposits of upper Jackson age. The Ocala represents a shallow water marine, offshore environment, and the Barnwell a littoral facies of coarser material, deposited near the upper Jackson strand line. The Tivola member represents a short-lived advance of the Ocala sea northward into the present area of outcrop of the Barnwell formation. --Auth.

1-1154. Butterlin, Jacques. MICROFAUNE ET ÂGE DE DEUX FORMATIONS CALCAIRES DE LA MARTINIQUE (PETITES ANTILLES FRANÇAISES) [MICROFAUNA AND AGE OF TWO LIMESTONE FORMATIONS OF MARTINIQUE (FRENCH LESSER ANTILLES)]: Soc. Géol. France, Compte Rendu, pt. 2, p. 42-43, Feb. 1959.

An upper Oligocene age is postulated for the limestone exposed in the Macabou cove on the E. coast of Martinique and a lower Miocene age (Aquitanian or Burdigalian) for the Beauséjour limestone of the Caravelle peninsula, on the basis of a study of foraminiferal faunas which confirmed the presence of Miogypsina species in the Macabou limestone and revealed the absence of Spiroclypeus bullbrooki and the greater abundance of Miogypsina relative to Lepidocyclina species in the Beauséjour limestone. --M. S.

1-1155. Boyer, W. W. PLAYA DEPOSIT IN THE BISHOP'S LODGE MEMBER OF THE TESUQUE FORMATION, SANTA FE COUNTY, NEW MEXICO: Jour. Sed. Petrology, v. 29, no. 1, p. 64-72, 4 illus., map, March 1959, 4 refs.

The examination of samples collected at 2 locations, one in the northern part of the Santa Fe quadrangle and the other about 4 mi. N., in the Tesuque quadrangle, discloses the presence of amorphous gypsum in amounts ranging from 55% to 88% in the silts and sands of the upper beds of the Bishop's Lodge member of the Tesuque formation [Tertiary]. Intense chemical weathering was noted in the volcanic and granitic components of the playa beds, and the theory is offered that frequent wetting and dessication during deposition were respondible for mildly acidic solutions which could have caused the chemical weathering observed. The discovery of a marked disconformity at the top of the playa beds separating them from the overlying Tesuque formation, coupled with changes in lithology, mode of sedimentation, and nature of terrain supplying the sediments, suggests that the Bishop's Lodge member and beds underlying it should be separated from the Tesuque formation. --Auth.

1-1156. Newcomb, R. C. YONNA FORMATION OF THE KLAMATH RIVER BASIN, OREGON: Northwest Sci., v. 32, no. 2, p. 41-48, geol. map, Feb. 1958, 7 refs.

A sequence of sedimentary and volcanic-sedimentary deposits of Pliocene age occurs beneath wide areas of the Klamath River basin in Oregon. It occupies a medial position in the eastward extension of the larger unit known as the volcanic rocks of the High Cascades. Its thickness ranges from zero to 2,000 ft. but averages 500 to 700 ft. in most of the area. These deposits are here named the Yonna formation; the type area is designated as the Yonna Valley and vicinity. --Auth.

1-1157. Kazakov, G. A., and N. I. Polevaya. SOME PRELIMINARY DATA ON ELABORATION OF THE POST PRECAMBRIAN SCALE OF ABSOLUTE GEOCHRONOLOGY BASED ON GLAUCONITES: Geochemistry [Geokhimiya], 1958, no. 4, p. 374-87, 2 graphs, 2 tables, 24 refs.

A systematic determination of the absolute geological age of the European part of the U. S. S. R. and of Czechoslovakia according to glauconites of different age from the Sinian system to the upper Eocene epoch, except for the Gotlandian and the Triassic systems, has been carried out. The determinations were made out by the K-Ar method (accuracy $\pm$ 10%) on carefully separated monomineralic fractions of glauconites from sands, clays and limestones having been altered by weathering (altogether 23 determinations). Some details of the method are described in the article. The character of Ar separation from glauconite with dependence on temperature has been ascertained, which shows that Ar begins to separate approximately at a temperature = 300°C., all the Ar being practically removed at t° = 500-600° C. --Auth.

5. PALEONTOLOGY

See also: Areal and Regional Geology 1-1117, 1-1119; Stratigraphy 1-1143, 1-1146, 1-1147, 1-1150, 1-1154; Fuels 1-1299.

1-1158. Wilson, L. R. A METHOD OF DETERMINING A USEFUL MICROFOSSIL ASSEMBLAGE FOR CORRELATION: Oklahoma Geology Notes, v. 19, no. 4, p. 91-93, graph, Apr. 1959, 8 refs.

A useful microfossil [palynological] assemblage for correlation may be determined graphically by plotting the number of specimens counted and the number of species identified in the count. At the point where the curve flattens markedly, it is assumed that a practical assemblage count for correlation has been completed. --Auth.

1-1159. Branson, Carl C. SOME PROBLEMATICAL FOSSILS: Oklahoma Geology Notes, v. 19, no. 4, p. 82-87, Apr. 1959, 16 refs.

The genus Conostichus was described by Lesquereux in 1876 with genotype by monotypy C. ornatus. Species subsequently referred to the genus are shown to be unrelated. The second group of organisms is discussed on the basis of numerous specimens and several new localities. It is concluded that there are 4 general types of such organic structures, none of certain assignment to taxonomic position. --Auth.

1-1160. Amsden, Thomas W. CHILIDIOPSIS BOUCOT: A RECENTLY DESCRIBED BRACHIOPOD GENUS, WITH SOME REMARKS ON THE HUNTON ORTHOTETACEA: Oklahoma Geology Notes, v. 19, no. 4, p. 74-77, 6 illus., chart, Apr. 1959, 10 refs.

The new genus Chilidiopsis embraces almost all of the American Silurian orthotetacids formerly assigned to Lamont's genus Fardenia. Type species is Fardenia reedsi Amsden from the Henryhouse formation of Oklahoma. Primary difference between Chilidiopsis and Fardenia is in the structure of the chilidium.

Orthotetacid brachiopods known to be represented in the Hunton group are listed, and some features of these brachiopods are noted. The Hunton species show some interesting stages in the development of the Orthotetacea. These brachiopods probably arose in the Ordovician with Fardenia, or some similar type, representing the ancestral form. --A. C. Sangree

1-1161. Imlay, Ralph W. SUCCESSION AND SPECIATION OF THE PELECYPOD AUCELLA: U. S. Geol. Survey, Prof. Paper 314-G, p. 155-69, 5 illus., table, Apr. 1959, 30 refs.

The pelecypod Aucella, of latest Jurassic and earliest Cretaceous age, has been subdivided into more than a hundred species on the basis of minor differences without allowing for biological variation, or for variation due to crowding that is normal for an attached gregarious pelecypod. As a result, in any large collection from a single locality, specimens can be selected that fit the definitions of a number of species and yet these so-called species are connected by many specimens showing transitional characteristics. Such an association appears, therefore, to represent a single variable population. If the species of Aucella are defined making allowance for variation, the number of species is greatly reduced, but the specific concepts can be grasped readily by geologists and used for mapping purposes. Seven zones based on species of Aucella can now be recognized easily in the field in North America, as has been demonstrated by geologists of the U. S. Geological Survey. -- Auth.

1-1162. Branson, Carl C. GENERIC ASSIGNMENT OF SOME FOSSIL CLAMS: Oklahoma Geology Notes, v. 19, no. 4, p. 94-95, Apr. 1959, 2 refs.

The generic name Allorisma has been suppressed and the name Wilkingia has been established. Twelve species of Allorisma which must be transferred are listed for the Oklahoma area and elsewhere. The American genus Caneyella Girty and its relationship to Posidoniella de Koninck and to Posidonia Bronn is also briefly discussed. --A. C. Sangree.

1-1163. Branson, Carl C. AN UNUSUAL SNAIL FROM THE EXCELLO SHALE: Oklahoma Geology Notes, v. 19, no. 3, p. 71-72, March 1959.

The snail was discovered in 1953 in a phosphatic nodule from the Excello shale (Pennsylvanian) of Rogers County, Oklahoma. The specimen as preserved is the umbilical slope and the rim of the first whorl, together with the external mold of the same area. It is 11.5 mm. in greatest dimension. The shell surface is marked by 6 small revolving ribs near the umbilicus, by 2 central broad folds, and by a narrow rib which divides to make 3 near the aperture. The outer margin is a broad flange, above which 5 toothlike projections extend outward and forward. Spine-bearing gastropods are relatively rare in the Paleozoic. The Oklahoma specimen most closely resembles Echinocirrus Ryckholt, 1860. --A. C. Sangree.

1-1164. Clarke, Arthur H., Jr., and Robert J. Menzies. NEOPILINA (VEMA) EWINGI, A SECOND LIVING SPECIES OF THE PALEOZOIC CLASS MONOPLACOPHORA: Science, v. 129, no. 3355, p. 1026-1027, illus., Apr. 17, 1959, 7 refs.: also pub. as. Columbia Univ., Lamont Geol. Observatory, Contr. no. 341.

In Dec. 1958, the Lamont Geological Observatory research vessel Vema dredged 4 specimens of Monoplacophora from the Peru-Chile Trench off northern Peru. This is the second discovery of living representatives of this class of Mollusca which was thought, until 1957, to have become extinct in the Devonian. The specimens are considered to represent a new subgenus and species: Neopilina (Vema) ewingi, and the discovery suggests that more relict types may exist alive in the deep sea off Central and South America. --Auth.

1-1165. Howard, Hildegarde. MIOCENE SULIDS OF SOUTHERN CALIFORNIA: Los Angeles County Mus., Contr. Sci., no. 25, p. 1-15, 3 illus., Aug. 15, 1958, 9 refs.

Two new Miocene fossil bird localities are recorded in Los Angeles County, California, one on Ventura Blvd. in Studio City, and one on Round Drive in El Sereno. A new species, Sula pohli, is described from the first-named locality; a new locality record for Sula stocktoni Miller is noted for the El Sereno locality, and a new genus, Paleosula, is established to contain this species. A previously unrecorded specimen from the Lomita diatomite is tentatively referred to Sula willetti Miller. --Auth.

1-1166. Miller, Loye, and Robert I. Bowman. FURTHER BIRD REMAINS FROM THE SAN DIEGO PLIOCENE: Los Angeles County Mus., Contr. Sci., no. 20, p. 1-15, 5 illus., March 6, 1958, 9 refs.

Additional avian fossil material from the San Diego Pliocene is assigned to 9 species, of which 3 are new to science: Colymbus subparvus, Sula humeralis, and Ptychoramphus tenuis. On the basis of this study, an ulna previously assigned to Miosula recentior Howard is here referred to the new Sula humeralis. --H. Howard.

1-1167. Downs, Theodore, Hildegarde Howard, Thomas Clements, and Gerald A. Smith. QUATERNARY ANIMALS FROM SCHUILING CAVE IN THE MOJAVE DESERT, CALIFORNIA: Los Angeles County Mus., Contr. Sci., no. 29, p. 1-21, 8 figs.,

2 tables, Apr. 14, 1959, 16 refs.

A total of approximately 150 fossil vertebrate remains were recovered, including 28 species of reptiles, birds and mammals. Five of these species represent clearly extinct animals including: Equus sp. small, Equus sp. large, cf. Tanupolama, Camelid sp. large, and Breameryx sp.; Gymnogyps amplus and Bubo virginianus are probably extinct ancestral forms.

The total faunal content and the sequence of geologic and climatic events indicate late Pleistocene age for the cave fauna, at least part of the cave sediments and the correlated alluvial fan remnant. The concentration of definite human cultural specimens stratigraphically above the remains of extinct vertebrates indicates probable difference in time of accumulation of the cultural and fossil material.

The record of varied types of life and mode of deposition indicates that the climate was different from that of today with possibly more equable or cooler conditions in the summer, a more abundant water source, and a greater amount of grass and woodland vegetation at hand. --T. Downs.

1-1168. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 2, no. 196, p. 65-69, Apr. 1959.

Ninety briefly annotated references are given, arranged alphabetically by author. References are world-wide and primarily for 1958.--A. C. Sangree.

1-1169. Cole, W. Storrs. LARGER FORAMINIFERA FROM ENIWETOK ATOLL DRILL HOLES: U. S. Geol. Survey, Prof. Paper 260-V, p. 743-84, 19 illus. (1 in pocket), 6 tables, Mar. 1959, 41 refs

Sixty-two species and one variety of larger Foraminifera from the Eniwetok Atoll drill holes K-1B, E-1, and F-1, were identified and many of these are described, discussed, and illustrated. Five species are listed from the Recent, Pleistocene, and Pliocene. There are 35 species, 3 new, and 1 variety reported from the Miocene. They are divided according to the Indo-Pacific time scale as follows: 5 species from Tertiary g, 4 species and 1 variety from Tertiary f, and 26 species from Tertiary e. Of the 23 species found in the upper Eocene, Tertiary b, 8 are new. One of these Eocene species is still living. No species were found which could be considered diagnostic of the Oligocene, Tertiary c and d.

The stratigraphic section is as follows: 0-615 feet, Recent, Pleistocene, and Pliocene; 615-860 feet, Tertiary g, Miocene; 860-1,080 feet, Tertiary f, Miocene; 1,080-2,687 feet, Tertiary e, Miocene; 2,687-2,780 feet, without diagnostic fossils; 2,780-4,553 feet, Tertiary b, upper Eocene.

The Eniwetok Atoll drill holes are correlated with those at Bikini Island using as points of reference the first appearance of diagnostic species. In the Eniwetok Atoll holes these points of reference, with one exception, are higher than those at Bikini. The top of the Lepidocyclina (Eulepidina) abdopustula zone (lowermost Tertiary e, Miocene) in all the drill holes occurs at nearly the same depth.

It is possible to correlate the major part of the section in these drill holes with surface outcrops of Saipan, the Malay Archipelago and other Pacific localities. However, the lower section of Tertiary e between 1,925 and 2,687 feet in the drill holes does not appear to have a stratigraphic equivalent so far reported from outcrops in the Pacific area.

Most of the sediments seem to have accumulated at depths somewhere between 20 and 70 fathoms, and the sediments containing larger Foraminifera probably accumulated in quiet water at a depth between 20 and 40 fathoms. These shallow-water conditions are indicated by the extreme scarcity of Cycloclypeus, a deep-water genus. --Auth.

1-1170. Bradshaw, John S. ECOLOGY OF LIVING PLANKTONIC FORAMINIFERA IN THE NORTH AND EQUATORIAL PACIFIC OCEAN: Cushman Found. Foraminiferal Research, Contr., v. 10, pt. 2, no. 196, p. 25-64, 43 figs. incl. charts, graphs, pls. 6-8, table, Apr. 1959, 58 refs.

Planktonic Foraminifera were examined from over 700 plankton tows taken at more than 400 stations in the North and equatorial Pacific Ocean. Twenty-seven species were identified and their frequencies determined.

Most specimens occur in the upper 100 m. of water. The species appear to be randomly distributed throughout the upper levels with no indication of layering of the abundant species.

The planktonic Foraminifera in the North and equatorial Pacific can be grouped into 4 faunas: a cold-water fauna, a transition fauna, and 2 warm-water faunas. The regions they inhabit appear to be differentiated by characteristic temperature and salinity values. The cold-water fauna is limited to the area occupied by the subarctic water mass while the warm-water faunas are found throughout the region occupied by the equatorial and center water masses.

Highest populations per unit volume of water occur in the subarctic water and at limited localities in the equatorial region, lowest concentrations being found in the central oceanic areas. Abundance may be controlled by variations in distribution of inorganic phosphate. --Auth.

1-1171. Cole, W. Storrs. NAMES OF AND VARIATION IN CERTAIN INDO-PACIFIC CAMERINIDS: Bulls. Am. Paleontology, v. 39, no. 181, p. 349-71, pls. 28-31, 7 tables, May 1959, 21 refs.

Operculinella Yabe (1918) and Operculinoides Hanzawa (1935) are demonstrated by the variation which occurs in the species Operculina ammonoides (Gronovius) and O. venosa (Fichtel and Moll) to be synonyms of Operculina d'Orbigny, 1826. The generic and specific names which have been applied to these 2 Indo-Pacific species are discussed. These species occur abundantly in warm water at various localities in the Indo-Pacific area at depths of 8 to 62 fathoms. The species O. bartschi Cushman and O. complanata (Defrance) are introduced for comparison with the other 2 species. --Auth.

1-1172. Stone, Dwayne D. TAXONOMIC KEY TO THE CONODONT GENUS STREPTOGNATHODUS: Compass, v. 36, no. 3, p. 157-60, illus., March 1959, 9 refs.

Characteristics of 21 species of the conodont genus Streptognathodus are placed in a taxonomic key. The key is intended to assist others in the identification of Streptognathids. A diagram is presented showing the various terms applied to the parts of this genus. --Auth.

1-1173. Wilson, L. R. GENOTYPE OF DENSOSPORITES BERRY, 1937: Oklahoma Geology Notes, v. 19, no. 3, p. 47-50, pl., March 1959, 7 refs.

The microslide containing the genotype of Densosporites, a Paleozoic spore genus, was damaged in the mail and later it was discarded. A photomicrograph of the genotype is published which indicates that Potonié and Kremp's 1954 emendation of the genus is based upon an incorrect morphological form. --Auth.

1-1174. Tynan, E. J. OCCURRENCE OF CORDAITES MICHIGANENSIS IN OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 3, p. 43-46, 5 illus. on pl., March 1959, 24 refs.

A specimen of Cordaites michiganensis from the Dawson coal of Oklahoma is described, illustrated, and compared with the type specimen of the Saginaw formation of Michigan. The Oklahoma occurrence extends the stratigraphic range into the Missourian. --Auth.

1-1175. Lakhanpal, Rajendra N. THE RUJADA FLORA OF WEST CENTRAL OREGON: California, Univ., Pubs. Geol. Sci., v. 35, no. 1, p. 1-66, 11 pls., 3 tables, 1958, 58 refs.

The Rujada flora represents the westward extension of an Oligocene forest that was widely distributed in central Oregon. It is found in beds of volcanic tuff associated with basalt flows, in the foothills of the Cascade Range some 23 mi. E. of Cottage Grove, Oregon. There are 40 known species, of which 3 conifers and 5 angiosperms have been described as new. Our collections include abundant foliage of the Asiatic conifer, Cunninghamia, a genus previously recorded only by pollen from the Tertiary of North America. There are 7 additional genera that are confined to Asia at the present time, but most of the remainder are now widely distributed both in the New and the Old World. Upper Oligocene age is indicated by the close relationship of the Rujada to the Bridge Creek flora of the John Day Basin, and by its stage of development in the Tertiary sequence of North America.

Most of the dominant species, including Alnus carpinoides, Fraxinus coulteri, Halesia oregona, Platanus dissecta, Pseudotsuga laticarpus, Pyrus oregonensis, Rhus varians, and Sequoia affinis, have living equivalents in temperate forests of today. A minority group has equivalents living in the subtropical forests of Asia and Central America; these include such abundant trees as Alangium thomae, Cunninghamia chaneyi, Exbucklandia oregonensis, Quercus consimilis, with a number of others, less common, all of which may range into temperate forests. Anona prereticulata and several rare species have modern equivalents that are typically tropical. By contrast, the Bridge Creek flora, from a region some 200 mi. inland, has a much lower representation of species that indicate a subtropical environment, and no known tropical members. The occurrence of the Rujada flora near the coast seems to account for its more tropical aspect, and may explain some other differences, such as the sparse record of Metasequoia occidentalis, a dominant of the inland floras. Mild winter temperatures and well-distributed rainfall are indicated by the composition of this forest which lived near the western margin of the continent.

It is to be expected that the Rujada flora, representing an ecotone between the Oligocene forests of the interior and the coast, would contain survivors of the Neotropical-Tertiary Geoflora which was so widespread in the western United States during Eocene time. But its temperate members greatly outnumber these relicts of an earlier and warmer epoch, and indicate that even on the continental borders the Arcto-Tertiary Geoflora had assumed the dominant position which it still maintains at middle latitudes in North America and Asia. --Auth. summ.

1-1176. Axelrod, Daniel I. THE PLIOCENE VERDI FLORA OF WESTERN NEVADA: California, Univ., Pubs. Geol. Sci., v. 34, no. 2, p. 91-160, pls. 13-23, 2 figs., map (in pocket), 1958, 54 refs.

The Verdi flora of 19 species is preserved in andesitic sandstones of the Coal Valley formation near Verdi, Nevada. The formation rests unconformably on Mio-Pliocene Kate Peak andesite on the S. side of the basin, but on the N. it lies on Oligocene Alta andesite or Jurassic granodiorite, the Kate Peak having been eroded there owing to uplift of the Peavine block by faulting following vulcanism. The Coal Valley rocks, which accumulated in a basin formed by downwarping and faulting, comprise (1) a lower, dark-colored, coarse conglomerate-breccia-sandstone member, (2) an olivine basalt, and (3) an upper, light-colored, sandstone-pebble conglomerate-shale-diatomite member. The flora comes from near the middle of the upper member, and fragmentary mammalian fossils lie several hundred feet above and below it.

The plants are preserved in sediments that were deposited in the central floodplain area at an altitude of approximately 2,500 ft., and in a region of comparatively low relief. The flora resembles modern vegetation at the lower margin of yellow pine forest on the W. slope of the Sierra Nevada and in southern California. Cottonwood and willow dominated the stream- and lake-borders on the Verdi floodplain. Nearby exposed slopes and well-drained flats supported an oak woodland and savanna, with chaparral present locally. A forest of pine and fir, with associates of manzanita, cherry, poplar, aspen, and willow lived chiefly in the bordering hills, extending locally into the lowlands on stream banks.

Verdi climate was subhumid, with yearly rainfall from 18 to 20 in. in the lowlands, and increasing to 25 in. at the forest margin. Precipitation was distributed as winter rains and summer showers in contrast to the present winter rain and snow. Average January temperature was at least 10°F. higher, and the frost-free season was fully 2 months longer than that at Verdi today.

The middle Pliocene (Hemphillian) age of the flora is indicated by its geographic, climatic, and cliseral relations, a conclusion in harmony with the age implications of associated mammalian fossils. --Auth.

See also: Geologic Maps 1-1083; Geomorphology 1-1131, 1-1132; Structural Geology 1-1138.

1-1177. Heiskanen, W. A., and F. A. Vening Meinesz. THE EARTH AND ITS GRAVITY FIELD: 470 p., 119 figs. incl. illus., 15 maps (2 fold.), charts, secs., diags., graphs, 54 tables, New York, McGraw-Hill Book Company, Inc., 1958, approx. 450 refs.

A great number of academic textbooks have been published on seismic and other geophysical methods but no comprehensive textbook which deals with the gravity field of the earth and the application of gravity anomalies in geodesy and geophysics. This gap in the literature on the earth sciences is filled by this book.

The book shows that the existing gravity anomalies can very effectively be used to investigate the location and the extent of the visible and invisible disturbing masses and to determine the figure of the earth, that means the detailed shape of the geoid. The undulations N of the sea level or geoid, the deflections of the vertical, θ, and the gravity anomalies, Δg, are caused only by the visible and invisible irregularities of the earth's mass. The gravity anomalies can be measured, the quantities N and θ can be computed from the Δg's. The geoid of Europe and its surroundings, computed in the Ohio State University, Columbus, is published.

The almost 90% complete isostatic compensation of the mountains and ocean masses, which make the undulations N of the geoid relatively small - less than $\pm$ 50 m. - and facilitates their computation, is handled in great extent. The thickness of the earth's crust is computed by the gravimetric method for different mountains. The obtained values agree well with the M-discontinuity obtained by seismic method. The most modern methods in gravimetry, like the gravity observations at sea and the gravimeters, are explained in detail. The practical part of the work, about 60% of the whole, is entirely new. It is based mostly on the studies of the last 3 decades. The approach is entirely new. The book emphasizes the significance of physical geodesy in geophysics and geodesy.

The geophysical part has been mostly written by Professor F. A. Vening Meinesz, retired Professor, Institute of Mineralogy, Geology, and Geophysics, University of Utrecht; the geodetic part is mostly the work of W. A. Heiskanen, Director of the Institute of Geodesy, Photogrammetry, and Cartography of the Ohio State University, and Director of the Finnish Geodetic Institute, Helsinki, who has with his students studied these problems for more than 3 decades.

This textbook will be valuable for the scientists of geodesy and geophysics and for advanced students in the different fields of the earth sciences. There is no comparable book in any language. --W. A. Heiskanen.

1-1178. Gilbert, R. L. G. AN INVESTIGATION INTO THE CALIBRATION OF GRAVITY METERS: Canada, Dominion Observatory, Contr., v. 3, no. 20, 11 p., 7 illus., table, 1958, 3 refs.; reprinted from: Geophys. Jour., London, v. 1, p. 330-40, 1958.

Gravity observations made with gravity meters over large gravity ranges have shown the instruments to be less satisfactory than is desirable. Figures are given showing the errors which have been found using 3 gravity meters under various field procedures, and some possible causes of error are discussed. The scale constants of the gravity meters are shown to change substantially with time, and a system is described which was built into one gravity meter in order to check the scale constant at any time. The results obtained from this device are tabulated and discussed; no satisfactory mechanism has been produced to explain the change in scale-constant, and the calibration device has some use, although not so much as had been hoped.

It is concluded that for accurate measurements of large gravity differences, careful operation of the gravity meters is essential, the calibration of the instrument being checked regularly; and that pendulum measurements may be preferable for the measurement of very large gravity differences. --Auth. summ.

1-1179. LaCoste, Lucien. SURFACE SHIP GRAVITY MEASUREMENTS ON THE TEXAS A. AND M. COLLEGE SHIP, THE "HIDALGO": Geophysics, v. 24, no. 2, p. 309-22, 14 figs., Apr. 1959, ref.

Gravity meter readings taken at sea are disturbed by the motion of the ship and thus involve accelerations thousands of times greater than the permissible error. These accelerations must be averaged out and/or correction made for them. A meter which allows this to be done is described, and data obtained on a surface ship are presented with such checks as were available. --Auth.

1-1180. Sandberg, C. H. TERRAIN CORRECTION CHARTS FOR TRANSITION FROM HAMMER CHARTS TO HAYFORD-BOWIE CHARTS: Geophysics, v. 24, no. 2, p. 323-29, 3 figs., 2 tables, Apr. 1959, 5 refs.

Two systems of terrain corrections are used for gravity surveys in the United States. For detailed gravity surveys, the terrain corrections are made with the Hammer charts, which extend out to a radius of about 13.6 mi. The Hammer charts emphasize the effect of local terrain. In large regional surveys it is advisable to use the Hayford-Bowie charts. These charts cover the entire surface of the earth.

Recently it has been found desirable, in specific instances, to incorporate the results of local surveys into larger surveys. In order to avoid repeating the terrain correction of the local surveys, it is necessary to be able to convert from one system of terrain corrections to the other.

Nine conversion zones have been completed and are presented in tables. --Auth.

1-1181. Thompson, L. G. D., and A. H. Miller. GRAVITY MEASUREMENTS IN SOUTHERN ONTARIO: Canada, Dominion Observatory, Pub., v. 19, no. 9, p. 321-78, illus., 2 maps, 1958, 16 refs.

The results of over 1,000 gravity observations made in southern Ontario up to 1952 have been adjusted to a common datum and are presented in the form of tables of principal facts and 2 Bouguer anomaly maps. A general analysis of the anomaly pattern is given which leads to the conclusion that the overlying Paleozoic rocks have little effect on the regional gravity pattern, and it is believed that the major anomaly trends are caused by belts of different densities in the Precambrian basement. --Auth.

1-1182. Oldham, C. H. G. GRAVITY AND MAGNETIC INVESTIGATIONS ALONG THE ALASKA HIGHWAY: Canada, Dominion Observatory, Pub., v. 21, no. 1, p. 1-22, 7 illus., 1958, 19 refs.

A gravity and magnetic survey was made along the Alaska Highway between Dawson Creek, British Columbia, and Fairbanks, Alaska, and 296 gravimeter stations were occupied. Ties were made to 10 pendulum stations covering a gravity range of 1486 mgls., and a calibration factor of 0.246804 mgl. per scale division was derived for the gravimeter. A study of profiles of elevation, Bouguer anomaly, magnetic intensity, and lithology leads to the following general interpretation. A 60 mgl. negative anomaly across the Rocky Mountains has been attributed to a 16,000 ft. crustal downways, while an anomaly of similar magnitude, but with steeper gradients, across the Cassiar Mountains is considered to be due to a mass of low density granite occurring within the mountain system.--Auth.

1-1183. Price, Charles E. MAGNETIC DIPOLE NOMOGRAMS: Geophysics, v. 24, no. 2, p. 330-34, 2 figs., Apr. 1959, 2 refs.

Two nomograms or alignment charts are presented for the solution of the magnetic-dipole equations for magnetic intensity over a dipping dipole $\Delta z = -m(d_1 r_1^{-3} - d_2 r_2^{-3})$ and $\Delta h = -m(e_1 r_1^{-3} - e_2 r_2^{-3})$. The 2 charts are used in conjunction with each other and are as accurate as is needed for field work. One of these charts will be found useful also in other calculations involving d/r^3. --Auth.

1-1184. Lovering, John F. THE MAGNETIC FIELD IN A PRIMARY METEORITE BODY: Am. Jour. Sci., v. 257, no. 4, p. 271-75, 2 figs., table, Apr. 1959, 10 refs.

The magnetic properties and mineralogical composition of the Moore County eucrite indicate that, while situated within about 10 km. of the surface of the silicate mantle of a primary meteorite body, this meteorite cooled through the Curie temperature of its magnetic constituents (about 560°C.) while in a magnetic field. If this field associated with the primary body was generated within a fluid metallic core, then at this time temperatures within the core must have been greater than about 1700°C. Furthermore the inclination of the direction of magnetization with the horizontal plane of crystal layering observed in the meteorite suggests that the Moore County eucrite formed close to either the 10°N. or 10°S. magnetic latitude of the primary body. --Auth.

1-1185. Runcorn, S. K. ROCK MAGNETISM: Science, v. 129, no. 3355, p. 1002-1012, 9 figs. incl. 5 maps, Apr. 17, 1959, 28 refs.

Minerals in certain rocks, principally basalts and red sandstones, acquire specific orientation of magnetic field at time of formation. Although local variation or change in the field can be effected by such factors as lightning, rock magnetism reliably records the position of the earth's magnetic poles at the time of rock formation. Detailed magnetic surveys of rocks of several ages in different parts of the world show the path of magnetic-pole shift, by inference polar shift, and indicate continental drift, particularly of Australia, during much of geologic time. Corroborative evidence is found in studies of paleowind directions, analyzed from eolian deposits, and paleoclimates, analyzed from lithologic and fossil characteristics. The existence of thermal-convection cells within the earth's mantle can explain polar wandering and continental drift. --M. Russell

1-1186. Glanville, C. R. LABORATORY STUDY INDICATES SIGNIFICANT EFFECT OF PRESSURE ON RESISTIVITY OF RESERVOIR ROCK: Jour. Petroleum Technology, v. 11, no. 4, p. 20-26, 2 illus., diag., 7 graphs, 5 tables, Apr. 1959, 8 refs.

The effect of overburden and fluid pressure on the resistivity of reservoir rock has been generally ignored in the quantitative interpretation of electrical logs. This paper shows from laboratory tests of 2 sandstone, 2 limestone and one dolomite formation that theoretical reservoir stress increases resistivity in varying amounts, depending upon depth (or stress) of formation, porosity, texture of rock and degree of water saturation.

The increased resistivity develops from increased formation resistivity factor and saturation exponent. In medium to low porosity the formation factor vs. porosity relation is affected in such a manner that a given porosity represents a higher formation factor in stressed rock. Indications are that pressure effect is probably significant in many reservoirs of medium to low porosity, especially at greater depths, and should be considered in the interpretation of their electrical log resistivities.

A simple and useful technique for pressure analysis of core plug samples was developed in the study which should be adaptable for routine measurements. --Auth.

1-1187. Knopoff, Leon. SCATTERING OF SHEAR WAVES BY SPHERICAL OBSTACLES: Geophysics, v. 24, no. 2, p. 209-219, 6 figs., Apr. 1959, 2 refs.

The problem of the scattering of plane S waves by a perfectly rigid, infinitely dense sphere is formulated. Calculations are made for the case in which the medium outside the sphere has a Poisson's ratio of 1/4. The range of sizes of obstacles used in the calculations includes radii very small compared with the wave length and radii comparable to the wave length. The scattered wave motions include a P mode and two S modes. One of the S modes has a formal correspondence to the SH mode of plane seismology; the other corresponds to the SV mode. At large distances from the obstacle the scattered P and S fields are computed together with the phase shifts in time occurring in all the components. For small obstacles, the scattered azimuthal S component is circularly symmetric; the scattered meridional S component diffraction pattern is generally elongated in the direction of propagation; the scattered P component is generally broadside to the direction of propagation. --Auth.

1-1188. Knopoff, Leon, and Freeman Gilbert. RADIATION FROM A STRIKE-SLIP FAULT: Seismol. Soc. America, Bull., v. 49, no. 2, p. 163-78, 11 figs. incl. diags., graphs, Apr. 1959, 5 refs.; also pub. as: California, Univ. (Los Angeles), Inst. Geophysics, Pub. no. 129.

Huygens' principle for elastodynamics has been applied to the problem of the radiation resulting from the introduction of a tear fault of finite length into an otherwise homogeneous medium. The fault has the following properties: (1) it is a surface across which the normal stresses vanish; (2) it has a rectangular shape with one dimension increasing at a constant rate in the direction of faulting; (3) the times of initiation and termination of the fault are both finite. The relative displacement on opposite sides of the fault is prescribed to be a step function of time. This configuration may be imaged in the earth's surface by symmetry, so that the problem

is reducible to that of a propagating strike-slip fault of finite length in an infinite elastic medium. The observed events are the P and S waves from the 2 ends of the fault. Simplified "first motion" responses are computed and compared with solutions derived from the usual theory of force couples. --Auth.

1-1189. Williams, M. L. THE STRESSES AROUND A FAULT OR CRACK IN DISSIMILAR MEDIA: Seismol. Soc. America, Bull., v. 49, no. 2, p. 199-204, graph, Apr. 1959, 3 refs.

In order to investigate some problems of geophysical interest, the usual consideration of symmetrical or antisymmetrical loading of an isotropic homogeneous plate containing a crack was extended to the case where the alignment of the crack separates 2 separate isotropic homogeneous regions. It develops that the modulus of the singular behavior of the stress remains proportional to the inverse square root of the distance from the point of the crack, but the stresses possess a sharp oscillatory character of the type $r^{-\frac{1}{2}} \sin(b \log r)$, which seems to be confined quite close to the point, as well as a shear stress along the material joint line as long as the materials are different.

The off-fault areas of high strain energy release reported by St. Amand for the White Wolf fault are qualitatively shown to be expected. --Auth.

1-1190. Richter, C. F. SEISMIC REGIONALIZATION: Seismol. Soc. America, Bull., v. 49, no. 2, p. 123-62, 7 maps, Apr. 1959, 57 refs.; also pub. as: California Inst. Technology, Div. Geol. Sci., Contr. no. 897.

In the U. S. S. R. earthquake risk is now officially mapped by division into areas numbered with the degrees of the Modified Mercalli intensity scale, to show maximum reasonably expectable intensity during future earthquakes on ground of the prevailing character. This paper presents and discusses maps on the same plan for the Los Angeles Basin and its vicinity, for California, and for the United States.

The effect of variation of ground from point to point can be shown only on a large scale. This is microregionalization; the map of the Los Angeles Basin is an example. Small-scale regionalization maps require generalization. Prevailing ground is selected, not strictly by percentage of area, but by considering the foundation likely to be used for construction, in mountainous areas mostly small alluvial patches less stable than the surrounding rock.

Regionalization and especially microregionalization can be used in construction and planning, as indicating maximum effects to be considered in designing permanent structures. In adjusting insurance rates, and in designing temporary structures, statistical frequency of occurrence is also involved.

Over small areas, regionalization depends largely on local variation of ground and geology; over large areas, distance from active faults must be considered. Attention should be given to the effect of structural trends and of wave path on the form of isoseismal curves.

Mapping for the Los Angeles Basin area is reasonably definite. That for California is fairly reliable, but less so in desert and mountain areas. That for the United States is in part highly speculative and subject to substantial change. --Auth.

1-1191. Duke, C. Martin, and David J. Leeds. SOIL CONDITIONS AND DAMAGE IN THE MEXICO EARTHQUAKE OF JULY 28, 1957: Seismol. Soc. America, Bull., v. 49, no. 2, p. 179-91, 5 maps, 4 cross-secs., table, Apr. 1959, 37 refs.

A report is given of observations of the effects of soil conditions on damage in Mexico City and Guerrero State in the earthquake of July 28, 1957. An isoseismal map is presented which identifies anomalies in intensity distribution which appear to be closely related to local geology and soil conditions. Comparison is made between Mexico City, 170 mi. from the epicenter and founded on the deep alluvium of Lake Texcoco, and several cities and villages 60 mi. from the epicenter, founded on firmer deposits or granite.

Mexico City suffered Modified Mercalli intensities of VII and IV, respectively, in that part of the lake-bed area where tall buildings stand, and on the more compact formations. Of the several cities 60 mi. from the epicenter, all suffered intensity V or less except Chilpancingo, where the intensity was VII to VIII. Chilpancingo rests on deep unconsolidated deposits; the other places are on rock or shallower unconsolidated deposits. --Auth.

1-1192. Peselnick, Louis, and Isidore Zietz. INTERNAL FRICTION OF FINE-GRAINED LIMESTONES AT ULTRASONIC FREQUENCIES: Geophysics, v. 24, no. 2, p. 285-96, 6 figs., 3 tables, Apr. 1959, 15 refs.

Ultrasonic pulse measurements in the 3 to 10 mc. / sec. frequency range were made of shear and dilatational absorption and velocity for 3 samples of fine-grained, homogeneous, and well-compacted limestones at atmospheric conditions. The complex moduli of elasticity were calculated for 2 limestone specimens of different grain size and porosity. A "hysteresis" or "solid-friction" type of loss for waves of dilatation was found in all 3 limestone specimens. Shear measurements made in one of the limestones also show a "hysteresis" type of loss.

Comparison of the dilatational loss in a single crystal of calcite to the dilatational loss in the limestones indicates that the internal friction for the limestone specimens probably occurs at the grain boundaries. --Auth.

1-1193. Manchee, E. B. DIRECT INTEGRATION OF CONTINUOUS VELOCITY LOGS: Geophysics, v. 24, no. 2, p. 335-43, 5 figs., Apr. 1959.

The number of conventional check shots associated with a continuous velocity log (CVL) well survey may be reduced to one or perhaps to zero if the integration of CVL travel times can be made at least as accurate as check-shot times. This should be possible if mud lag and instrumental lag can be taken into account. By the use of a centralizer on the CVL sonde and a caliper log, mud lag may be calculated. A digital computer may be used to simplify reduction of the data. Results to date are encouraging but further testing of the method will be necessary. --Auth.

1-1194. Martner, Samuel T., and Neil R. Sparks. THE ELECTROSEISMIC EFFECT: Geophysics, v. 24, no. 2, p. 297-308, 9 figs., Apr. 1959, 7 refs.

The electroseismic effect manifests itself as an electrical potential generated in the subsurface by the passage of seismic waves. It can be detected at the surface of the ground with electrode pairs. The time of occurrence of the voltage clearly distinguishes the effect from either the ionization potential produced at the time of explosion or the seismic electric effect produced coincident with the arrival of seismic

waves at the surface of the ground.

Evidence is presented which associates the electroseismic effect with the base of the weathered layer and demonstrates its characteristics in several areas and at various distances from the shotpoint. Its immediate utility appears to be that of determining the travel time through the weathered layer at the shotpoint. --Auth.

1-1195. Backus, Milo M. WATER REVERBERATIONS - THEIR NATURE AND ELIMINATION: Geophysics, v. 24, no. 2, p. 233-61, 20 figs., Apr. 1959, 8 refs.

In offshore shooting the validity of previously recorded seismic data has been severely limited by multiple reflections within the water layer. The magnitude of this problem is dependent on the thickness and the nature of the boundaries of the water layer.

The effect of the water layer is treated as a linear filtering mechanism, and it is suggested that most apparent water reverberation records probably contain some approximate subsurface structural information, even in their present form.

The use of inverse filtering techniques for the removal or attenuation of the water reverberation effect is discussed. Examples show the application of the technique to conventional magnetically recorded offshore data. It has been found that the effectiveness of the method is strongly dependent on the instrumental parameters used in the recording of the original data. --Auth.

1-1196. Werth, G. C., D. T. Liu, and A. W. Trorey. OFFSHORE SINGING - FIELD EXPERIMENTS AND THEORETICAL INTERPRETATION: Geophysics, v. 24, no. 2, p. 220-32, 8 figs., Apr. 1959, 8 refs.

At some locations offshore, seismic records degenerate into nearly sinusoidal waves or simple combinations of nearly sinusoidal waves despite the fact that the recording may be made with little or no seismic filtering. Results from field experiments indicate that this "singing" phenomenon is caused by the reflections themselves exciting an acoustic resonant layer formed by the ocean surface and bottom. A simple theoretical model predicts the mode of excitation and the frequency, depth and range dependence which are verified by controlled field experiments. --Auth.

1-1197. Richards, T. C., and D. J. Walker. MEASUREMENT OF THE THICKNESS OF THE EARTH'S CRUST IN THE ALBERTAN PLAINS OF WESTERN CANADA: Geophysics, Apr. 1959, v. 24, no. 2, p. 262-84, 11 figs. incl. map, Apr. 1959, 13 refs.

Following seismic observations in the Albertan plains from the Ripple Rock explosion, a refraction line some 81 mi. long and parallel to the frontal thrust of the Rocky Mountains and about 60 mi. to the E. thereof was observed by 2-way shooting.

Fifteen seismic parties, spaced at roughly uniform intervals along the line and using the method of close geophone correlation, were employed, the object being to map as many refractors or reflectors as possible as far as the Mohorovičić discontinuity. The results indicate that this discontinuity occurs at a minimum depth of 43 km. where the velocity is about 8.2 km./sec., while an intermediate layer with a minimum depth of 29 km. and velocity 7.2 km./sec. has been registered. Other intermediate refractors were observed. These results are compared with those obtaining in other parts of the American continent and elsewhere.

The operational, instrumental, and theoretical aspects of the work are discussed. -- Auth.

1-1198. Hersey, J. B., Elizabeth T. Bunce, R. F. Wyrick, and F. T. Dietz. GEOPHYSICAL INVESTIGATION OF THE CONTINENTAL MARGIN BETWEEN CAPE HENRY, VIRGINIA, AND JACKSONVILLE, FLORIDA: Geol. Soc. America, Bull., v. 70, no. 4, p. 437-65, 13 figs. incl. maps, secs., graph, 2 fold. pls., 4 tables, Apr. 1959, 38 refs.; also pub. as: Woods Hole, Mass., Oceanog. Inst., Contr. no. 973.

Forty seismic-refraction and reflection profiles on the eastern continental shelf and adjacent deep-water areas of the Atlantic Ocean, from 29°39' to 36°30'N. and 73°30' to 81°10'W. trace the transition from deep-oceanic to continental-type structures. The transitional area divides naturally into 3 parts: the continental shelf, the Blake Plateau, and the adjoining deep-water area.

The results on the continental shelf are correlated with adjacent continental geology. The deepest horizon traced along the shelf is interpreted as granitic basement, which has compressional velocities of 5.82-6.1 km./sec. At the southern extremity it is at a depth of 6 km., shoals to 0.86 km. near Cape Fear, and deepens N. of Cape Hatteras to more than 3 km. N. of Charleston, South Carolina, there is excellent depth correlation with granitic basement in coastal wells; to the S. all deep wells are inland. Age correlations are based on well data near the coast, which indicate to us that most of the observed section is Cretaceous.

On the Blake Plateau, several layers (1.83-4.5 km./sec.) are interpreted as sedimentary. A 5.5-km./sec. layer is found only S. of a line from 30°30'N., 78°W. to Cape Canaveral. Velocities higher than 5.5 km./sec. have been measured on 6 profiles on the Blake Plateau. The 5.5-km./sec. layer and a 6.2-km./sec. layer appear to form a positive feature to the S. of the above-mentioned line. Higher velocities, 8.0 km./sec. and 7.28 and 7.3 km./sec., which are probably not the same horizon, are found at markedly different depths. Possibly these represent the M layer and ultrabasic material, depending on relations not now known.

The deep-water area is a continental slope and rise modified by the Blake Plateau and by a ridge trending southeastward from Cape Fear and deepening from about the 1500-fathom contour to more than 2000 fathoms (3657 m.). The ridge is underlain by thick low-velocity layers (1.83-2.96 km./sec.), interpreted as sediments, and higher-velocity layers which form a distinct linear structure having the same general trend as the ridge. At its northwestern end this trend terminates against a thick lower-velocity section interpreted as a sediment-filled trough. South of the ridge profiles are similar to those of the ocean basins. Excellent seismic-refraction evidence of faulting indicates subsidence of the ridge relative to its surroundings. A hypothesis interprets the ridge as a former chain of islands and reefs on a structural trend colinear with the Cape Fear Arch.

The structural pattern formed by the Piedmont crystallines and the Peninsular Arch of Florida and the Cape Fear Arch and the ridge resembles that formed by the Japanese archipelago, the Ryukyus,

and the Bonin ridge. The pattern of the trough of the Blake Plateau and the deep-water area is somewhat similar to such modern features as Exuma Sound and the Tongue of the Ocean in the Bahamas. Such comparisons should not be regarded as strictly homologous but are suggested as possibly reflecting similarities in deep-lying tectonic activity. Similarly it would seem fruitful to consider similarities of deep structure beneath isolated seamounts, chains of seamounts, submerged ridges, island arcs, and mature mountain ranges. --Auth.

1-1199. Shor, George G., Jr. REFLEXION STUDIES IN THE EASTERN EQUATORIAL PACIFIC: Deep-Sea Research, v. 5, p. 283-89, 7 figs., 1959, 5 refs.

A limited seismic reflexion survey has been made in portion of the equatorial Pacific far from land and shielded from turbidity-current deposition. It covers the boundary between present-day clay deposition in the N. and present-day carbonate deposition in the S. The profiles show that the sediment is decidedly thicker in the carbonate area and provide evidence for a greater rate of accumulation in valleys than on hills. --Auth.

7. GEOCHEMISTRY

See also: Geologic Maps 1-1085; Stratigraphy 1-1157; Mineralogy 1-1232, 1-1236; Geohydrology 1-1267; Mineral Deposits 1-1280, 1-1288; Fuels 1-1305.

1-1200. Dinnin, Joseph I. RAPID ANALYSIS OF CHROMITE AND CHROME ORE: U. S. Geol. Survey, Bull. 1084-B, p. 31-68, 4 illus., 3 tables, Apr. 1959, 43 refs.

Rapid methods for the determination of the major and of some minor constituents of chromite and chrome ore permit the complete analysis of a dozen or more samples to be performed in about 5 days with a precision comparable to that of the more conventional methods. The sample is fused with sodium peroxide in a zirconium crucible. The major constituents are determined from aliquots of a single solution of sample prepared by acidifying a water extraction of the fusion product. Cr_2O_3 is determined volumetrically by ferrous ammonium sulfate-dichromate titration; SiO_2 is determined spectrophotometrically using the reduced silicomolybdate color; total Fe is determined by a modified differential spectrophotometric method using orthophenanthroline. An additional aliquot, electrolyzed in a mercury cathode apparatus, is used for the titration of MgO with Varsene, and for the spectrophotometric determinations of Al_2O_3 and TiO_2 with alizarin red-S and Tiron, respectively. The minor constituents are determined on another aliquot from which CrO_2Cl_2 has been volatilized by fuming with $HClO_4$ and HCl; MnO, V_2O_3 and NiO are then determined spectrophotometrically using the permanganate, phosphotungstovanadate, and α-furildioxime colors, respectively. Separate portions of sample are used for the determination of CaO by Varsene titration, H_2O by the Penfield tube method and FeO by one or more methods. The precision of the method was tested by comparing the results of the rapid procedures with those obtained by conventional procedures on standard materials. --Auth.

1-1201. Edge, R. A., R. R. Brooks, L. H. Ahrens, and S. Amdurer. SOME RECONNAISSANCE OBSERVATIONS ON THE COMBINED USE OF ION-EXCHANGE ENRICHMENT AND SPECTROCHEMICAL ANALYSIS FOR THE DETERMINATION OF TRACE CONSTITUENTS IN SILICATE ROCKS: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 337-41, 2 figs., 2 tables, March 1959, 19 refs.

A reconnaissance investigation has been made of the possible combined use of ion-exchange enrichment (cation and anion) and spectrochemical analysis for the determination of several rare elements, notably Ag, Be, Bi, Cd, Cs, In, La, Mo, Nb, Sn, Pb, Tl, Y, and Zn, in silicate rocks and allied materials. Observations which have been carried out on granite G-1, a specimen of Cape granite, and diabase W-1, indicate that many of these elements should be easily detected in a wide variety of rocks and soils. The scope of the combined procedures seems to be immense, and it is evidently possible to determine several elements in a single operation; the combined procedure should be particularly useful for investigating the general geochemistry of Bi. --Auth.

1-1202. Ellis, A. J. THE SYSTEM Na_2CO_3-$NaHCO_3$-CO_2-H_2O AT TEMPERATURES UP TO 200°: Am. Jour. Sci., v. 257, no. 4, p. 287-96, 4 figs., 5 tables, Apr. 1959, 12 refs.

The equilibrium conditions in the system above were obtained by a differential vapor pressure method and the results up to 200° are reported.

From measurements of the differences in vapor pressure between pure water and a salt solution it is possible in principle to obtain activity coefficients for the ions in solution. The vapor pressures of sodium chloride and sodium carbonate solutions up to 200° are given, but it was not possible to obtain results of sufficient accuracy to derive activity coefficients. --Auth.

1-1203. Fyfe, W. S., and G. W. Valpy. THE ANALCIME-JADEITE PHASE BOUNDARY: SOME INDIRECT DEDUCTIONS: Am. Jour. Sci., v. 257, no. 4, p. 316-20, fig., Apr. 1959, 17 refs.

From a consideration of phase changes involving analcime, some estimates have been made of the equilibrium pressures of the reaction: analcime = jadeite + H_2O. The results, although subject to large uncertainties, suggest that equilibrium pressures from existing experimental data are too high, particularly at the low temperature end of the system. Entropy and volume data for analcime confirm this conclusion and indicate that the boundary should have positive slope at low temperatures. --Auth.

1-1204. Hemley, J. Julian. SOME MINERALOGICAL EQUILIBRIA IN THE SYSTEM K_2O-Al_2O_3-SiO_2-H_2O: Am. Jour. Sci., v. 257, no. 4, p. 241-70, 6 figs., 6 tables, Apr. 1959, 28 refs.

An experimental investigation was made at elevated temperatures and pressures of the hydrolysis of K-feldspar to mica + silica and of mica to kaolinite. Values of the equilibrium quotient, m_{KCl}/m_{HCl}, were determined at temperatures ranging from 200° to 550°C. The solution pressure for most of the runs was 15000 p. s. i. although determinations were made

at both higher and lower pressures. The reactions are exothermic, and the equilibria show a marked shift to higher acidities with increasing temperature. The equilibrium curves for the 2 reactions are essentially parallel. Above about 350°C. the assemblage mica-kaolinite changes to mica-pyrophyllite-boehmite, and at still higher temperatures mica-pyrophyllite-andalusite is formed. At 400°C. and 15000 p. s. i. the equilibrium quotient is $10^{2.7}$ for the assemblage K-feldspar-mica-silica, and $10^{1.3}$ for the assemblage mica-pyrophyllite-boehmite. The experimental equilibrium quotients probably do not differ from the thermodynamic equilibrium constants of the reactions by more than a factor of 5 up to temperatures of 350°C. or higher.

The experimentation shows that the most important controls on the fields of stability of these several minerals are the K^+/H^+ activity ratio and the temperature. At a given temperature and with increasing K^+/H^+ ratio, the fields of kaolinite, mica and K-feldspar are successively traversed. Similarly, at constant K^+/H^+ ratio with increasing temperature this same sequence is observed. The free energy drive of hydrolysis decreases with increasing temperature. Thus the alteration potential of hydrothermal solution would increase with decreasing temperature provided the rate of migration were sufficiently rapid in comparison with the rate of reaction with the wall rock. Experiments at solution pressures of 5000 and 35000 p. s. i. show that the effect of solution pressure on these equilibria is relatively small. An increase in pressure increases the extent of hydrolysis, whereas a decrease in pressure shifts the equilibria in the opposite direction.

The experimental results have particular application to hydrothermal alteration and the genetic interpretation of various alteration mineral patterns. --Auth.

1-1205. Hill, V. G. PHASE TRANSFORMATION IN ZINC SULPHIDE: Can. Mineralogist, v. 6, pt. 2, p. 234-59, 8 figs., 10 tables, 1958, 30 refs.

The study of phase transformation in the zinc sulfide system shows that the 3C:2H equilibrium at 1020°C. ± 5°C. is metastable. At 1010°C. ± 10°C. the 4H polytype is the stable phase, and, from the determination of the variation of cubic-hexagonal packing relationship with temperature, it is suggested that the polytypes all have a stability range between that of the 2H and 3C polymorphs. On this basis, the 3C:2H transition is seen to be of the diffuse first-order type. The reaction trend in the development of a polytype near the 2H:3C equilibrium temperature is

3C → 3C:2H (intergrowth) → polytypes
or 2H → 2H:3C (intergrowth) → polytypes

If the reaction temperature is far removed from the 2H:3H metastable equilibrium temperature, then this transformation from 2H to 3C or vice versa first occurs, and thereafter the polytype develops from the intergrowth and/or polymorph first formed. It is suggested that the nucleation and growth of the various phases is a probability function dependent on starting material, temperature and reaction time. --Auth.

1-1206. Muan, Arnulf. PHASE EQUILIBRIA IN THE SYSTEM MANGANESE OXIDE-SiO_2 IN AIR: Am. Jour. Sci., v. 257, no. 4, p. 297-315, 3 figs., table, Apr. 1959, 33 refs.

Phase relations in the system manganese oxide - SiO_2 in air have been investigated in the temperature range 990-1571°C., using the quenching technique. The data obtained permit the construction of a phase diagram showing stability relations in the liquidus temperature region as well as at subsolidus temperatures. For sake of simplicity the phase relations are illustrated in the form of a projection into a chosen join through the ternary system. The resulting diagram has the appearance of a binary system, with "binary invariant" situations as follows: a peritectic exists at 1230°C., with cubic Mn_3O_4, tephroite ($2MnO \cdot SiO_2$) and liquid coexisting in equilibrium with a gas phase of O_2 partial pressure equal to 0.21 atm. At 1206° C. tephroite, $MnO \cdot SiO_2$ solid solution (rhodonite), liquid and gas are present together in what appears as an eutectic situation. Tridymite (SiO_2), $MnO \cdot SiO_2$(ss), liquid and gas exist together in equilibrium in an apparently peritectic situation at 1272°C., and cristobalite together with 2 liquids and gas are the equilibrium phases at approximately 1700°C. In the subsolidus region the following apparently invariant situations have been determined: at 1204°C. cubic Mn_3O_4, tephroite and $MnO \cdot SiO_2$(ss) coexist in equilibrium with a gas phase of O_2 partial pressure equal to 0.21 atm. Tetragonal Mn_3O_4, a phase probably analogous to the mineral braunite (Mn_2O_3(ss)), and $MnO \cdot SiO_2$ (ss) are in equilibrium with this gas at 1168°C., while at 1048°C., Mn_2O_3(ss), $MnO \cdot SiO_2$(ss) and tridymite are the stable phases in air. In addition, "invariant" situations also result from the tridymite-cristobalite inversion at approximately 1470°C. and the inversion from tetragonal to cubic Mn_3O_4 at approximately 1160°C. --Auth.

1-1207. Smith, F. Gordon. TRANSPORT AND DEPOSITION OF THE NON-SULPHIDE VEIN MINERALS. VI. QUARTZ: Can. Mineralogist, v. 6, pt. 2, p. 210-21, 3 figs., 3 tables, 1958, 15 refs.

Data on solubility of quartz in water are shown to obey equations of the type

$$\log S\%v = \frac{-a}{T} + 2,$$

where S%v is weight percent SiO_2 in solution at constant volume, a is a constant depending on specific volume, and T is the absolute temperature. The approximate solubility of quartz in near-neutral hydrothermal solutions in depth along a steep geothermal gradient is calculated. --Auth.

1-1208. Ringwood, A. E. ON THE CHEMICAL EVOLUTION AND DENSITIES OF THE PLANETS: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 257-83, 4 figs., 4 tables, March 1959, 48 refs.

It is assumed that planets have accreted at low temperature from a cloud of dust and gas of cosmic composition. Subsequent melting may cause reduction of metallic oxides by carbonaceous compounds which were trapped during accretion. The metal so produced would segregate and form a core. Chemical evidence indicates that the metallic phase would consist chiefly of Fe, Ni, and Si. The higher the reduction temperature, the higher will be the content of Si in the Ni-Fe. The density variation of terrestrial planets can be explained by differing degrees of reduction of the primitive non-volatile material. According to this view, Mars is composed of completely oxidized cosmic non-volatile material, whereas Mercury is highly reduced, with

most of its Si occurring in the metal phase. Venus, the earth, and meteorites exhibit intermediate stages of reduction, and therefore, intermediate densities.

Examination of the chemistry and mineralogy of meteorites supports the suggested theory of origin. The mineralogy is similar to blast furnace assemblages, suggesting analogy between the processes of metal production. Prior's rules, concerning the inverse variation of oxidized and reduced Fe in meteorites, and Ni content of chondritic Fe, are readily explained. The reduction hypothesis provides a mechanism for chondrule formation. Textural and chemical evidence indicates that they formed within the meteoritic planet by rapid crystallization due to loss of water below 1000°C.

If meteorites and the earth are to possess similar non-volatile compositions, the earth's core must contain about 20% of Si. Occurrence of some Si in the core would enable explanation of its probable density and elasticity, which are not satisfactorily explained by the properties of pure Ni-Fe.

When the metal which is produced by reduction near the surface of the earth segregates to form a core it is out of chemical equilibrium with the mantle because the high temperatures and pressure at the core-mantle boundary displace the equilibria. The reactions chiefly concerned are:

$$Ni^{o} + Fe^{++} = Ni^{++} + Fe^{o}$$

$$Si^{o} + 2Fe^{++} = Si^{++++} + 2Fe^{o}$$

A substantial e.m.f. is therefore generated at the core-mantle boundary. This may be of importance in connection with the theory of the earth's magnetic field. Accompanying ionic diffusion effects near the boundary may cause density changes and convection in the core. Resultant changes in the composition of the mantle near the boundary may be responsible for the change in gradient of seismic velocities observed by Jeffreys and Gutenberg. A further effect of this process is to cause a steady contraction in the volume of the core. --Auth.

1-1209. Ďurovič, S. CONTRIBUTION TO THE LOGNORMAL DISTRIBUTION OF ELEMENTS: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 330-36, 3 figs., March 1959, 8 refs.

This paper contains a discussion on the equation expressing the course of the density of probability distribution in a lognormal distribution. A proof is given that the most probable value and the geometrical mean are 2 different magnitudes. Therefore the following plot must be valid:

$$\log \frac{\text{abundance}}{\text{most frequent concentration}} = 3{\cdot}4539$$

which, on the other hand differs from the plot published by Ahrens. The respective theoretical considerations are shown on the distribution of Pb in Canadian granite. --Auth.

1-1210. Murthy, M. V. N. ON THE CRYSTALLIZATION OF ACCESSORY ZIRCON IN GRANITIC ROCKS OF MAGMATIC ORIGIN: Can. Mineralogist, v. 6, pt. 2, p. 260-63, 1958, 13 refs.

A solution to the problem of the time of crystallization of zircon in granitic magmas is attempted by examining the probable behavior of the Zr^{4+} ion, according to its crystallochemical properties. It is suggested that within a single intrusion of granitic rock zircon crystallization is early (intratelluric) and is of short duration. --Auth.

1-1211. Beus, A. A. THE ROLE OF COMPLEXES IN TRANSFERS AND ACCUMULATIONS OF RARE ELEMENTS IN ENDOGENIC SOLUTIONS: Geochemistry [Geokhimiya], 1958, no. 4, p. 388-97, 12 refs.

Under conditions of high concentration of strong bases and acids, complex compounds are the most probable form of existence in aqueous and supercritical solutions for rare elements that are typical amphoteres (Be, Nb, Ta, Zr, Hf, etc.) or very weak bases (Sc, rare earths, etc.). In such solutions F, Cl, CO_3, PO_4, etc., may be added. The disintegration of rare-metal complexes and the formation of solid phases may be chiefly caused by 2 factors: 1) reaction of dissociated ions of the rare-element complex with solution components, 2) hydrolysis of the complex in the process of pH increase in the solution. On the basis of the law of mass action it has been shown that in these processes a regular separation even of elements with similar properties must occur, the complexes of which show different stability. At the same time elements differing by their chemical properties, the acidocomplexes of which show a similar stability, may precipitate into the solid phase practically simultaneously. The change of pH is considered as an important and continuously acting factor of rare-element concentration.

The behavior of rare elements with similar properties, the complexes of which are of different stability, is shown on examples of separating Nb and Ta, rare earths of the Ce and Y groups, etc., in the process of pegmatite formation. At the same time the closest paragenesis of Be, Nb, and Zr in granite pegmatites, of Nb and Zr in albitized alkaline and acid rocks, etc., is considered from the point of view of similar stability of their complex compounds. --Auth.

1-1212. Semenov, Ye. I., and R. L. Barinskiy. THE COMPOSITION CHARACTERISTICS OF THE RARE EARTHS IN MINERALS: Geochemistry [Geokhimiya], 1958, no. 4, p. 398-419, 5 graphs, table, 12 refs.

The composition of rare earths is shown by 2 similar curves linking the points of separate even and odd lanthanides. According to the value of the maximum, 3 types of rare-earth composition have been distinguished: a strongly selective (>45-50), a selective (>30) and a complex type (<30). Besides the well-known maxima on Ce, Dy, and Yb, abrupt maxima of lanthanides in minerals has been outlined. A correlative bond between near-lanthanides and a relative constancy in the ratios of even and odd elements of one pair has been established. The correlative bond of the separate lanthanides depends on the proximity of the ionic radius (and electronic configuration) of one pair of elements. The typical ratios of pair lanthanides are somewhat disturbed in strongly selective compositions. In minerals with maxima on Ce, Nd, and Gd, Y is nearly absent, whereas in compositions with maxima of Dy and Yb, large amounts of Y are present.

Therefore in the mineralogical-geochemical respect it has been suggested to place the boundary between the Ce and Y groups between Tb and Dy. It is reasonable to distinguish the pair-lanthanide groups according to the leading even elements; the cerium group (Ce, La), the neodymium group (Nd, Pr), the samarium group (Sm, Eu), the gadolinium group (Gd, Tb), the dysprosium group (Dy, Ho), the erbium group (Er, Tm) and the ytterbium group (Yb, Lu). --Auth.

1-1213. Heier, K. S., and S. R. Taylor. DISTRIBUTION OF Li, Na, K, Rb, Cs, Pb AND Tl IN SOUTHERN NORWEGIAN PRE-CAMBRIAN ALKALI FELDSPARS: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 284-304, 11 figs. incl. 2 geol. sketch maps, 7 tables, March 1959, 25 refs.

The concentrations of Li, Rb, Cs, Pb, and Tl have been determined spectrographically and Na and K by flame photometer in 88 feldspars from Precambrian basement rocks of southern Norway. Rock types include gneisses, augengneisses, anatexe granites, diapire (post-orogenic) granites, and small and large pegmatites. Analytical procedures are described.

Normal K/Rb ratios are found except for those from some large pegmatite feldspars which are enriched in Rb, and feldspars from arendalites which are relatively impoverished. The latter effect is shown to be related to feldspar structure and bulk composition. Changes in the K/Rb ratio are traced with increasing differentiation in the Fevig diapire granite. Feldspars from small pegmatites are similar in composition to the country rock. Those from large pegmatites fall into 3 compositional groups.

The trace element content of the feldspars seems in general to reflect the differences in geological conditions under which they were formed. --Auth.

1-1214. Borovik-Romanova, T. F., A. F. Sosedko, and Ye. N. Savinova. THE POTASSIUM-RUBIDIUM RATIO IN MINERALS FROM PEGMATITES OF THE KOLA PENINSULA, AS SHOWN BY SPECTROGRAPHIC ANALYSIS: Geochemistry [Geokhimiya], 1958, no. 4, p. 420-29, 4 graphs, table, 11 refs.

The ratios of the K/Rb content in minerals from pegmatites of the same pegmatite field of the northern part of the Kola peninsula [U. S. S. R.] but showing different mineralogical composition and structure, have been studied. It has been ascertained that the K/Rb ratio in microclines varies from 106 in ordinary pegmatitic dikes to 7 in microclines from more complex differentiated pegmatitic dikes. In microclines from zonal pegmatites, a decrease of the K/Rb ratio from 26 to 15 has been observed in the direction from the contact to the center. For micas of the pegmatitic field under investigation, an enrichment of Rb with respect to K from NW. to S. in the field has been observed; in zoned pegmatites the enrichment of micas proceeds from the contact to the core. It also has been noted that the K/Rb ratio in microclines taken from pegmatitic veins belonging to a definite stage of pegmatite formation in similar paragenetic associations remains rather constant, and from it it is in some degree possible to judge of the mineralogical composition and structure of the pegmatite under investigation. The gradual concentration of Rb, as well as of other rare elements, being especially conspicuous in such minerals as microclines and micas may be explained by the formation of pegmatites of such a type from the residual melt-solution during its gradual differentiation. --Auth.

1-1215. Odikadze, G. L. ON THE PRESENCE OF NIOBIUM AND TANTALUM IN MUSCOVITES FROM PEGMATITES OF THE DZIRULSK CRYSTALLINE MASSIF: Geochemistry [Geokhimiya], 1958, no. 4, p. 479-83, table, 5 refs.

The presence of a constant Nb and Ta admixture as well as the existence of small amounts of Be, Ca, Sn, Ti, V and W in muscovites from various paragenetic complexes of pegmatite formations of the Dzirulsk massif has been established. The chemical and spectral study of muscovite specimens from pegmatites of Karelia and the Ural mountains has shown the presence of Nb in all investigated muscovites. The least content (0.003% of Nb_2O_5) has been found in muscovites of pegmatites from Chupa (Karelia). The maximum content (0.05% Nb_2O_5) proved to be in muscovites from pegmatites of the Dzirulsk massif. Nb and Ta in muscovites are considered an isomorphous impurity. --Auth.

1-1216. Getling, R. V., and Ye. N. Savinova. SOME DATA ON THE BORON CONTENT OF IGNEOUS ROCKS IN THE TURINSK ORE DISTRICT, URAL MOUNTAINS: Geochemistry [Geokhimiya], 1958, no. 4, p. 471-78, graph, 2 tables, 16 refs.

Spectroscopic analysis of the B content in igneous rock of the Turinsk (Ural) Cu district was performed on 16 pre-skarn pyroxene gabbros, granodiorites and diorites; 5 extrusive mafic porphyrites; and 5 post-skarn spessartite lamprophyres. With 2 exceptions the pre-skarn intrusives ranged from 20-30 p. p. m. B, about equal to the concentration of the post-skarn lamprophyres and about [half] that of the B content of the extrusives. The overall B concentration of the Turinsk igneous rocks is around 3 times the B content of the average igneous rock. B analyses made on single mineral components of selected intrusive and extrusive rocks illustrate the marked concentration of B in plagioclase and not in hornblende or augite. No credence is placed on early fixation of B as datolite or axinite during crystallation of mafic and ultramafic rocks. This mineralization is thought to arise from later hydrothermal action. A plot of the B content in rocks compiled from several investigators points out the relative constancy of B in mafic and silicic rocks (+10 p. p. m.) with a possible trend to a higher B content in mafics and intermediates than in silicics. The original B content of a magma is decisive in determining the extent of isomorphous substitution or B mineralization throughout the rock crystallization history. --Auth.

1-1217. Heydemann, Annerose. ADSORPTION AUS SEHR VERDÜNNTEN KUPFERLÖSUNGEN AN REINEN TONMINERALEN [ABSORPTION FROM VERY DILUTE COPPER SOLUTIONS ON CLAY MINERALS (in German, with English abs.)]: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 305-29, 3 photomicrographs, 10 figs., 12 tables, March 1959, 47 refs.

The adsorption of Cu by various clay minerals, and also by quartz and calcite, was studied experimentally at different pH-values and concentrations. The clay minerals used were grain size fractions with an equivalent diameter < 2 or $< 0{\cdot}6\,\mu$ of 2 kaolinites, one fireclay-type kaolinite, 2 illites, and 2 montmorillonites. The surface properties of these samples were determined in part in electron micrographs and by the glycol-retention method.

Cu is adsorbed by clay minerals and by quartz according to the Freundlich adsorption isotherm, whereas in the case of calcite a chemical reaction takes place. The adsorption capacity of the clay minerals is increased by raising the pH as well as the Cu concentration. The influence of concentration and pH-value is most pronounced with the kaolinites; there is only a small influence with the montmorillonites. The adsorption capacity related to 100 g. of clay increases in the following order: kaolinite, fireclay-type kaolinite, illite, montmorillonite. How-

ever, the adsorption capacity related to 100 m^2. surface of kaolinite and fireclay-type kaolinite are of the same order of magnitude, the adsorption capacity per surface unit for illite and montmorillonite can be considerably smaller under certain conditions.

The significance of such adsorption for geochemical processes is briefly discussed. --Auth.

1-1218. Korolev, D. F. THE ROLE OF IRON SULFIDES IN THE ACCUMULATION OF MOLYBDENUM IN SEDIMENTARY ROCKS OF THE REDUCED ZONE: Geochemistry [Geokhimiya], 1958, no. 4, p. 452-63, 4 tables, 28 refs.

The role of iron sulfides in the process of Mo accumulation in sedimentary rocks enriched in organic matter is being determined. It is shown experimentally that Mo amounting to 70-96% of the total content, according to conditions, is coprecipitated with iron sulfides from solutions whose compositions are approximately similar to natural solutions. The study of natural iron sulfides has shown that most of the Mo is concentrated in melnikovite, apparently in the form of a sorbed sulfide compound. Coarsely-crystalline pyrites contain minor amounts of Mo, due to loss of Mo in the aging process. Thus the bond of Mo in sedimentary rocks with horizons enriched in sulfides is of a regular character. This regularity is to a certain degree true also for elements associated with Mo - Ni, Co, V, etc. --Auth.

1-1219. Yershov, V. M., and A. I. Shcheglova. GERMANIUM IN MINE WATERS OF THE KIZELOV COAL BASIN: Geochemistry [Geokhimiya], 1958, no. 4, p. 490-92, table, 6 refs.

The average Ge content in pit waters of the Kizelov coal field has been determined: it equals 1.5 mg. /$m.^3$. The water pumped out from 40 pits probably carries out about 200 kg. of Ge per year. The comparison with the Ge amount being yearly carried out with the coal bears witness to a strong bond of Ge with organic coal matter. --Auth.

1-1220. Gerling, Ye. K. EFFECT OF METAMORPHISM ON GEOLOGIC AGE AS DETERMINED BY THE LEAD METHOD: Geochemistry [Geokhimiya], 1958, no. 4, p. 363-73, 6 graphs, 3 tables, 30 refs.

The applicability of the graphic method of calculating the true age of a mineral and of the time of its last metamorphism, proposed by Ahrens and Veserill, is described in this article. With this method it has been determined that the true age of Belomore [White Sea region] uraninites is 1950 x 10^6 years, not 1800 x 10^6 years as was formerly thought. These changes in the uraninite age were taken into account in calculating a new value for the constant of K-capture by K^{40} according to radiogenic Ar included in micas. The newly calculated value proved to be equal to 5.4 x 10^{-11} year. This value differs by 10% from the former (6.02 x 10^{-11} $year^{-1}$) and differs only by 3% from the value obtained in the U. S. A. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 1-1207, 1-1212, 1-1214, 1-1215, 1-1217; Sedimentary Petrology 1-1252, 1-1265; Mineral Deposits 1-1282.

1-1221. Kraus, Edward H., Walter F. Hunt, and Lewis S. Ramsdell. MINERALOGY - AN INTRODUCTION TO THE STUDY OF MINERALS AND CRYSTALS: 5th ed., 686 p., 736 illus., New York, McGraw-Hill Book Company, Inc., 1959.

This textbook, which was first issued in 1920, has been modernized and brought up to date. Information and data are given for the identification of crystals and minerals by their physical, optical, and chemical properties, as well as by X-ray analysis and blowpipe methods. For this 5th edition revisions have been made throughout the book, and Chaps. 13 and 14, now entitled Chemical Mineralogy and Chemistry, and Formation and Occurrence of Rocks and Minerals, respectively, have been rewritten and expanded. In Chap. 16, Descriptive Mineralogy, the chemical formulas of many minerals have been changed to conform with the modern interpretation of their composition based upon extensive X-ray studies. Chap. 18, Classification of Minerals According to Elements, gives full information concerning the advances made in the uses and production of the minerals described in the book. The Tables for the Determination of Minerals have, for nearly 4 decades, proven their value. The book is well adapted for use by students of mineralogy, geology, chemical engineering, forestry, and the general public. --E. H. Kraus.

1-1222. Mursky, G. A., and R. M. Thompson. A SPECIFIC GRAVITY INDEX FOR MINERALS: Can. Mineralogist, v. 6, pt. 2, p. 273-87, table, 1958.

The work was undertaken to provide a practical, and as far as possible, a complete list of specific gravities of minerals. An accurate specific gravity determination can usually be made quickly, and this information when combined with other physical properties commonly leads to rapid mineral identification. The work should not be regarded as an index of all known minerals, as specific gravities of many minerals are unknown or known only approximately and are omitted from this list.

The list, in order of increasing specific gravity, includes all minerals without regard to other physical properties or to chemical composition. The designation I or II after the name indicates that the mineral falls in the classes of minerals described in Dana, System of Mineralogy, 7th ed., volume I or II. Those not so designated are silicates which will appear in volume III (in preparation). Hydrocarbons have been omitted.

Determinations of most specific gravities were made on natural materials; a few made on synthetic material are indicated by the letter S after the value. The letter C indicates calculated value. In the case of some isomorphous series and complicated groups such as apatite, amphiboles, pyroxenes, and clay minerals, only well-known members are listed. Specific gravities for varietal names or unnamed minerals are generally omitted. --From auth. introd.

1-1223. Bowley, R. E. DIRECT COLOUR PRINTS FROM POLISHED AND THIN SECTIONS: Can. Mineralogist, v. 6, pt. 2, p. 294-97, 1958.

A method is described which eliminates one process in the usual two-stage production of a color film transparency from which color prints are made. The ap-

paratus and materials used include: 1) microscope fitted with polarizing equipment and camera with cut-film holder; 2) Bausch and Lomb Tri-Simplex projector, adapted for use; 3) Ansco Printon paper; 4) Ansco Printon developing kit; 5) Ansco gelatin filters. The process of exposing and processing film of polished sections and thin sections is described. --A. C. Sangree.

1-1224. Watkins, Joel S. GRAPHS FOR THE ELIMINATION OF THE HARTMAN NET IN THE DETERMINATION OF REFRACTIVE INDICES IN HIGH DISPERSION MEDIA: Am. Mineralogist, v. 44, no. 3/4, p. 314-21, 7 figs., March-Apr. 1959, 5 refs.

Direct reading charts are presented which eliminate graphical solutions (Hartmann Nets) required for index of refraction determinations in high dispersion media. Geometric proofs and construction procedures are explained. A special chart adapted to high dispersion liquids based on Tsuboi's classic work determines the composition of plagioclase feldspars from a single determination of N_x'. --Auth.

1-1225. Howell, J. E., and K. R. Dawson. TECHNIQUE FOR OPTICAL IDENTIFICATION OF IRON-BEARING DOLOMITES: Can. Mineralogist, v. 6, pt. 2, p. 292-94, fig., 1958, 7 refs.

The technique was developed to test for compositional differences between the dolomite from fragments and from the matrix of dolomitic arenites, because X-ray powder patterns failed to solve the problem. The method is based on a direct relation between the refractive indices of carbonates and their chemical composition, and is simply a rapid and accurate method for determining a critical refractive index. --From auth. introd.

1-1226. Dawson, K. R., and J. A. Maxwell. POSSIBLE LOSS OF SODIUM AND POTASSIUM DURING FUSION OF PLAGIOCLASE FELDSPARS: Can. Mineralogist, v. 6, pt. 2, p. 288-90, table, 1958, 4 refs.

A method for identification of plagioclase feldspars involves formation of a glass and determination of its refractive index. An investigation was made to test the reliability of the technique when samples are fused by an acetylene-air flame and in a high-temperature electric furnace. Specimens of albite from Quebec and labradorite from Newfoundland were used. No significant loss in Na or K occurred. Glasses formed by the fusion of the plagioclase powders under these conditions probably suffer no change in composition. --A. C. Sangree.

1-1227. Hawley, J. E., and L. G. Berry. MICHENERITE AND FROODITE, PALLADIUM BISMUTHIDE MINERALS: Can. Mineralogist, v. 6, pt. 2, p. 200-209, 4 illus., 2 tables, 1958, 6 refs.

Two palladium bismuthides from nickeliferous ores of the Frood Mine, Sudbury, Ontario, detected and described by C. E. Michener some years ago, are re-described and named michenerite and froodite. Michenerite is an isometric form of $PdBi_2$ with a pyrite structure, $a = 6.68$ Å. It is grayish-white, soft, brittle, with no cleavage. Froodite is gray, soft, brittle, with one perfect cleavage (100) and one less perfect (001), monoclinic - C2/m with $a = 12.75$, $b = 4.29$, $c = 5.67$, $\beta = 102^{\circ}52'$, containing 4 $[PdBi_2]$. It is identical with synthetic α-$PdBi_2$ formed at moderate temperatures. --Auth.

1-1228. Nickel, Ernest H. THE COMPOSITION AND MICROTEXTURE OF AN ULVÖSPINEL-MAGNETITE INTERGROWTH: Can. Mineralogist, v. 6, pt. 2, p. 191-99, 5 illus., 2 tables, 1958, 4 refs.

Chemical analysis, X-ray diffraction, and electron microscopy have been used to determine the composition and microtexture of an ulvöspinel-magnetite intergrowth in titaniferous Fe from Rouville County, Quebec. The composition of the ulvöspinel is estimated to be $(Mg_{0.42}Fe_{0.58})(Fe_{1.03}Ti_{0.71}Al_{0.26})O_{3.90}$. It has a spinel-type structure with $a = 8.460$ Å. Electron micrographs show an exsolution texture consisting of pleonaste lamellae and magnetite cubes in an ulvöspinel matrix. --Auth.

1-1229. Pabst, Adolf. ON THE HYDRATES OF SODIUM CARBONATE, A CORRECTION, AND THE CRYSTALLOGRAPHY OF TRONA: Am. Mineralogist, v. 44, no. 3/4, p. 274-81, 2 figs., 4 tables, March-Apr. 1959, 16 refs.

Reexamination of material earlier described as the hemipentahydrate of sodium carbonate, $Na_2CO_3 \cdot 2\ 1/2H_2O$, proves it to be $Na_3H(CO_3)_2 \cdot 2H_2O$, trona. It is shown that all reports of the hemipentahydrate probably involved the same misidentification. A new setting of trona is based on the cell dimensions a_o 20.11 Å, b_o 3.49, c_o 10.31, β 103° 8', space group I2/c. This is reconciled with previous settings, and a revised angle table and indexed powder pattern are given. --Auth.

1-1230. Dawson, K. R., and Ann Sabina. A CANADIAN OCCURRENCE OF FAIRCHILDITE AND BUETSCHLIITE: Can. Mineralogist, v. 6, pt. 2, p. 290-91, table, 1958, ref.

Fairchildite ($K_2CO_3 \cdot CaCO_3$) and buetschliite ($3K_2CO_3 \cdot 2CaCO_3 \cdot 6H_2O$) have been identified from the trunk of a partially burned hickory tree near Deseronto, Ontario. Material was collected from the top of the burned stump and from the ground beneath the fallen trunk. Spectrographic analyses indicate that Mg and Ca are the major constituents, with minor amounts of K and P. Table gives X-ray powder patterns for the 2 minerals. This constitutes the first recorded occurrence of these minerals in Canada. --A. C. Sangree.

1-1231. Benington, Fred. PRELIMINARY IDENTIFICATION OF CRYSTALLINE PHASES IN A TRANSPARENT STALACTITE: Science, v. 129, no. 3357, p. 1227, May 1, 1959, 5 refs.

Of 2 crystalline phases found in a cavern stalactite, the major phase is mirabilite, whereas the minor phase, according to preliminary data, is a new mineral, sodium hemicalcium sulfate dihydrate, which is unstable at temperatures above 25°C. --Auth.

1-1232. Vasileva, Z. V. SULFUR-BEARING APATITES: Geochemistry [Geokhimiya], 1958, no. 4, p. 464-70, 5 tables, 7 refs.

In analyzing numerous apatites from various deposits in the Soviet Union, the author has paid attention to the character of the isomorphous replacement between P, S, and Si. In contrast to el-

lastadite, in which every two P^{5+} atoms have been accordingly replaced by S^{6+} and Si^{4+}, in apatite from the Shishim mine [Ural] the Si/S ratio = 1.34 : 1, i.e. an excess of Si not compensated by S, has been observed, which in the author's opinion has been compensated by the replacement of the bivalent O^2 ion by a monovalent ion $(OH)^-$. In this case the isomorphous replacement may be expressed by the following schemes: $2P^{5+} \rightarrow Si^{4+}\ S^{6+}$ and $(3P^{5+})O^{2+} \rightarrow (S^{6+}\ 2S^{4+})\ (OH)^-$.

In the apatite from the Nadezhnoe deposit, in which P^{5+} has been replaced by S^{6+}, and the composition corresponds to the formula $Na_6Ca_4S_6O_{24}Cl_2$, the isomorphous replacement corresponds to the scheme: $Ca^{2+}\ P^{5+} \rightarrow Na^+S^{6+}$. The other apatites from the Aldan contain rare earths and Na along with S and Si. In apatites of such composition the following isomorphous replacement is possible: $2Ca^{2+} \rightarrow Na^{1+}TR^{3+}$, $2P^{5+} \rightarrow S^{6+}Si^{4+}$; $Ca^{2+}P^{5+} \rightarrow TR^{3+}Si^{4+}$; $Ca^{2+}P^{5+} \rightarrow Na^{1+}S^{6+}$.

Data on specific gravity, refractive indices and lattice dimensions of apatites depending on the percent of the S content in them have been compared in the article. --Auth.

1-1233. Trotter, J., and W. H. Barnes. THE STRUCTURE OF VANADINITE: Can. Mineralogist, v. 6, pt. 2, p. 161-73, 3 figs., 4 tables, 1958, 23 refs.

Two-dimensional Fourier and difference syntheses have been used to solve and refine the structure of vanadinite, $Pb_5(VO_4)_3Cl$. The isostructural relationship of vanadinite to other apatite-like minerals has been confirmed. The chlorine ion is surrounded by 6 divalent Pb ions at the corners of a regular octahedron; the co-ordination of O and V is tetrahedral. Interatomic distances are given, and the accuracy of the results is assessed in terms of the standard deviations of atomic positions and of interatomic distances. --Auth.

1-1234. Ross, Malcolm. MINERALOGICAL APPLICATIONS OF ELECTRON DIFFRACTION. II. STUDIES OF SOME VANADIUM MINERALS OF THE COLORADO PLATEAU: Am. Mineralogist, v. 44, no. 3/4, p. 322-41, 11 illus., 4 tables, March-Apr. 1959, 17 refs.

A method of obtaining precise unit-cell data from oriented electron diffraction powder patterns is described. Partial unit-cell data obtained from such patterns and a description of the crystal habit are given for the following minerals: hewettite ($CaV_6O_{16} \cdot 9H_2O$), barnesite ($Na_2V_6O_{16} \cdot 3H_2O$), a new hydrated calcium vanadyl vanadate, corvusite ($V_2O_4 \cdot 6V_2O_5 \cdot nH_2O$), a "corvusite-like" mineral ($V_2O_4 \cdot 5V_2O_5 \cdot xH_2O$), fernandinite ($CaO \cdot V_2O_4 \cdot 5V_2O_5 \cdot 14H_2O$), navajoite ($V_2O_5 \cdot 3H_2O$), a "corvusite-like" mineral associated with navajoite, steigerite ($Al_2O_3 \cdot V_2O_5 \cdot 6\ 1/2H_2O$), fervanite ($Fe_4V_4O_{16} \cdot 5H_2O$), and simplotite ($CaV_4O_9 \cdot 5H_2O$. For many of these minerals the unit-cell data are new. Structural relations between several of these minerals are indicated. --Auth.

1-1235. Thompson, Mary E., and Alexander M. Sherwood. DELRIOITE, A NEW CALCIUM STRONTIUM VANADATE FROM COLORADO: Am. Mineralogist, v. 44, no. 3/4, p. 261-64, 2 tables, March-Apr. 1959, 2 refs.

Delrioite, $CaO \cdot SrO \cdot V_2O_5 \cdot 3H_2O$, was found on the dump at the portal of the Jo Dandy mine, Montrose County, Colorado. The mine is in a V-U deposit in the Salt Wash member of the Morrison formation of Late Jurassic age. The mineral occurs as radial aggregates of pale yellow-green fibrous acicular crystals. Unit cell data for delrioite are not available, but the X-ray powder diffraction pattern is unique. The d-spacings of the strongest lines are, in Ångströms: 6.5(S), 4.95(MS), 4.40(M), 3.55(M), 3.45(MS).

Delrioite is biaxial negative, with indices of refraction $\alpha = 1.783$, $\beta = 1.834$, $\gamma = 1.866$, all ± 0.003, 2V medium to large. It is pleochroic with X colorless, Y pale yellow, and Z slightly deeper yellow. The hardness is about 2; the measured specific gravity is 3.1±0.1.

The chemical analysis shows, in percent: CaO 13.30, SrO 24.50, V_2O_5 46.00, $H_2O(+)$5.64, $H_2O(-)$ 9.24, SiO_2 1.30, total 99.98.

Delrioite is named for A. M. del Rio, who first found V (erythronium) in North America. --Auth.

1-1236. Saha, Prasenjit. GEOCHEMICAL AND X-RAY INVESTIGATION OF NATURAL AND SYNTHETIC ANALCITES: Am. Mineralogist, v. 44, no. 3/4, p. 300-313, 4 figs., table, March-Apr. 1959, 35 refs.

During phase-equilibria studies in the subsolidus region of the system $NaAlSiO_4$ (nepheline)-$NaAlSi_3O_8$ (albite)-H_2O, analcite was synthesized from glasses of a wide range of composition. Geochemical, optical, and X-ray investigations were carried out, and it was found that there is a wide range of solid solution of analcite. Determination of water content and unit cell constant proved that the variation of these properties are linear functions of the silica content of the analcites. The synthetic analcites were found to be isotropic, but the refractive index variation was not found to be linear. The experimental data have been discussed in the light of previous structural investigations of analcites. Data on the composition of natural analcites have been collected from literature and summarized. --Auth.

1-1237. Bassett, William A. THE ORIGIN OF THE VERMICULITE DEPOSIT AT LIBBY, MONTANA: Am. Mineralogist, v. 44, no. 3/4, p. 282-99, 10 figs., 3 tables, March-Apr. 1959, 13 refs.

The country's largest vermiculite mine at Libby, Montana, has been studied, and the origin of the vermiculite deposit investigated. The ore body lies in an augite pyroxenite which has been altered to biotite, hydrobiotite, and vermiculite. Numerous syenite dikes may be observed in the pyroxenite.

Ion exchange experiments show that biotite alters to vermiculate at room temperature in solutions of 0.001 molar magnesium or calcium chloride. Roy and Romo's evidence for the instability of vermiculite under hydrothermal conditions and its application to the origin of the vermiculite deposit at Libby, Montana, is discussed. A mechanism is suggested for the formation of hydrobiotite, a regularly interstratified biotite-vermiculite.

It is concluded that augite altered to biotite at the time of the intrusion of the syenite dikes, and that the biotite was altered to hydrobiotite and vermiculite by supergene solutions. --Auth.

1-1238. Hicks, W. D. EUDIALYTE AND EUCOLITE IN CANADA: Can. Mineralogist, v. 6, pt. 2, p. 297-98, 1958.

Eudialyte has been defined as a silicate of Na, Ca, Fe, and Zr, with hydroxyl and Cl. Eucolite is considered to be a variety with Ce and Mn. Considerable uncertainty exists, however, as to the chemistry of the 2 minerals. The only consistent difference was in the optic sign, eudialyte being uniaxial positive and eucolite uniaxial negative.

Samples of syenite rock from Pontiac County, western Quebec, and from Seal Lake area, Labrador, were analyzed. Vivid pink granular aggregates of a vitreous silicate mineral in the former sample were identified as eucolite, and fine-grained vitreous reddish-pink material in the latter was identified as eudialyte. No published data has been found on Canadian occurrences of these minerals. In the hand specimen they could be mistaken for garnet. --A. C. Sangree.

1-1239. Stewart, D. B. NARSARSUKITE FROM SAGE CREEK, SWEETGRASS HILLS, MONTANA: Am. Mineralogist, v. 44, no. 3/4, p. 265-73, fig., 3 tables, March-Apr. 1959, 15 refs.

Narsarsukite, $Na_2TiSi_4O_{11}$, is described from the second of 3 localities in the Sweetgrass Hills, Montana. Narsarsukite is associated with manganpectolite, quartz, calcite, and galena in veins cutting an orthoclase-albite-aegirine-quartz hybrid rock in a zone adjacent to a syenite stock. Optical properties of the minerals and an indexed X-ray powder-diffraction pattern of narsarsukite are given.

This occurrence of the assemblage aegirine-quartz-narsarsukite is similar to other occurrences of narsarsukite in the Sweetgrass Hills and at Narsarsuk, Greenland. It is concluded that the formation of narsarsukite depends upon the reaction of emanations from alkalic magmas with siliceous wallrock under conditions such that a high partial pressure of O is present. --Auth.

1-1240. Brown, G., and I. Stephen. A STRUCTURAL STUDY OF IDDINGSITE FROM NEW SOUTH WALES, AUSTRALIA: Am. Mineralogist, v. 44, no. 3/4, p. 251-60, 2 figs., 2 tables, March-Apr. 1959, 16 refs.

Iddingsite from New South Wales, Australia, is polycrystalline and consists of goethite and a layer lattice silicate. In the alteration of olivine to iddingsite the original lattice of close-packed oxygens appears not to have been greatly disturbed, and the changes have occurred by the movement of cations within small regions to form microcrystals of the alteration products. The parallel alignment of the components explains why it behaves optically as a single crystal.--Auth.

1-1241. Nickel, Ernest H., J. F. Rowland, and J. A. Maxwell. THE COMPOSITION AND CRYSTALLOGRAPHY OF NIOCALITE: Can. Mineralogist, v. 6, pt. 2, p. 264-72, 5 figs., 4 tables, 1958, 3 refs.

Niocalite is monoclinic with $\underline{a}$ = 10.83, $\underline{b}$ = 10.42, $\underline{c}$ = 7.38 Å, and β = 109°40'. On the basis of 2 chemical analyses, the generalized formula is $(Ca, Nb)_{16}Si_8(O, OH, F)_{36}$. The similarity of niocalite to woehlerite, hiortdahlite, and låvenite is discussed. --Auth.

1-1242. Searle, Alfred B., and Rex W. Grimshaw. THE CHEMISTRY AND PHYSICS OF CLAYS AND OTHER CERAMIC MATERIALS: 3d ed. rev., 942 p., illus., diags., graphs, tables, New York, Interscience Publishers, Inc., 1959, refs.

Contents: The nature of clays and other ceramic materials; atomic and crystalline structure; crystal structure of the silicates; the crystal structure of non-siliceous ceramic materials; the identification and estimation of minerals in ceramic materials; the chemical and mineralogical composition of ceramic raw materials; physical and structural properties of raw ceramic materials; the influence of water in ceramic systems; changes in the physical state of ceramic materials brought about by the removal of water; the equilibrium state and physico-chemical reactions; chemical changes in ceramic materials; physical changes in ceramic materials; strength and allied properties; miscellaneous properties of ceramic materials.

1-1243. Faust, George T., John C. Hathaway, and George Millot. A RESTUDY OF STEVENSITE AND ALLIED MINERALS: Am. Mineralogist, v. 44, no. 3/4, p. 342-70, 8 figs., 7 tables, March-Apr. 1959, 34 refs.

Stevensite was shown by Faust and Murata to be a montmorillonite group mineral. Brindley subsequently proposed that stevensite consists of an interlayered talc-saponite mineral. A restudy of stevensite shows that it is not an interlayered talc-saponite mineral, but rather a type of defect structure. The defect structure arises from a deficiency in the total number of ions in octahedral coordination. This concept of stevensite as a defect structure seems to fit all of the data from X-ray, infrared, differential thermal analysis, and solution studies.

Ghassoulite is shown to contain 0.36% Li_2O and 3.22% F. Experimental studies show it to be like hectorite instead of stevensite.

Synthetic stevensites, the interstratified "saponite-talc" of Alietti, and hanušite are interpreted in terms of the results reported here.

Two new chemical analyses are reported: Ghassoulite from Djebel Ghassoul, Morocco, and a mixture containing stevensite from Mine Creek, North Carolina.

It is recommended that the names hanušite (= stevensite+pectolite) and ghassoulite (= hectorite) be relegated to the synonomy. --Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Geochemistry 1-1213; Mineralogy 1-1237.

1-1244. Hooker, Marjorie. DATA OF ROCK ANALYSES - V. BIBLIOGRAPHY AND INDEX OF ROCK ANALYSES IN THE AUSTRALIAN PERIODICAL AND SERIAL LITERATURE: Geochim et Cosmochim. Acta, v. 15, no. 4, p. 342-69, March 1959.

Rock analysis data published from 1914 to 1953 inclusive are presented. The bibliography contains 240 references from 35 journals, with the number of analyses and the rock types in each reference indicated. The geographic index shows the distribution of the 968 analyzed rocks, by states and areas within Australia, and in Antarctica, New Guinea, and New Hebrides. The rock-name index refers to the bibliographic references.

Pts. I-IV of the Data of Rock Analyses series dealt with Africa, New Zealand, and Iceland. Pt. IV was listed as GeoScience Abstracts 1-203. --A. C. Sangree.

1-1245. Dawson, K. R. AN APPLICATION ON MULTIVARIATE VARIANCE ANALYSIS TO MINERALOGICAL VARIATION, PREISSAC-LACORNE BATHOLITH, ABITIBI COUNTY, QUEBEC: Can. Mineralogist, v. 6, pt. 2, p. 222-33, 5 maps, 4 tables, 1958, 10 refs.

Seventy-eight specimens of the quartz monzonite from the Preissac-Lacorne batholith were thin sectioned, and modal analyses were made using the point count technique. The constituent minerals are grouped into 4 categories: total mafics, quartz, plagioclase, and potassium feldspar. A qualitative univariate analysis of the geographic distribution and percentage data is illustrated by map figures and compared with the quantitative method. The geological significance of areal variations is discussed and the data are subjected to multivariate variance analysis which confirms suspected regional homogeneity and disproves the existence of significant local variations. --Auth.

1-1246. Goodspeed, G. E. SOME TEXTURAL FEATURES OF MAGMATIC AND METASOMATIC ROCKS: Am. Mineralogist, v. 44, no. 3/4, p. 211-50, 12 illus., March-Apr. 1959, 24 refs.

The textural features of magmatic rocks have been described, with the emphasis placed upon their relationship to the crystallization sequence of the magma. Examples have been chosen from the basaltic and diabasic dikes in the vicinity of Cornucopia, Oregon, the shonkinite-granite porphyry sequence at Yogo Peak in the Little Belt Mountains of Central Montana, and a few other localities. The textural differences of the orthomagmatic as compared to the late magmatic or deuteric pattern of crystallization have been noted. Where it has appeared that the deuteric fraction had been involved in mass flowage the term deutero-magmatic is suggested.

For metasomatic rocks, textural features to illustrate various stages of crystal growth have been described, such as the development of porphyroblasts, glomeroblastic aggregates, and the final crystalloblastic pattern. Most of the examples are taken from occurrences near Cornucopia, Oregon, and Buffalo Hump, Idaho, with a few references to other localities.

The textural features resulting from the mobilization of metasomatized rocks, such as rheomorphic dikes and rheomorphic breccias have been briefly noted. These commonly show magmatic textures superposed on metasomatic ones. For many igneous rocks, however, later crystalloblastic textures are superposed on the earlier orthomagmatic textures. Textural features alone are not always adequate for petrogenetic interpretations but for some occurrences like granitic intrusions they may furnish clues as to whether the body has evolved from an orthomagma or from mobilized metasomatized material, namely a neomagma. --Auth.

1-1247. Condie, Kent C. THE ORIGIN OF INCLUSIONS IN THE MINERAL RANGE PLUTON, UTAH: Compass, v. 36, no. 3, p. 184-92, geol. map, March 1959, 14 refs.

The Mineral Range is located in Beaver and Millard counties in southwestern Utah. The exposed pluton in this range is batholithic in size, covering approximately 80 sq. mi. It is composed essentially of granite; porphyritic granite, adamellite, and granodiorite are of local abundance. A series of ptygmatically folded gneisses and shists outcrops on the W. side of the range and is considered early Precambrian in age. Inclusions are abundant in the Mineral Range pluton, especially along the W. side of the range. They include basic inclusions and carbonate inclusions; the majority are of the first type. The zone of basic inclusions starts N. of Pass Canyon and continues W. along the W. side of the range essentially paralleling the schistosity and gneissic foliation in the Precambrian Wildhorse Canyon series. After due consideration of the possible theories bearing on origin of the inclusions, the writer considers that metasomatic replacement of previously existing crystalline and sedimentary rocks offers an adequate explanation.--Auth.

1-1248. Smith, Charles H. BAY OF ISLANDS IGNEOUS COMPLEX, WESTERN NEWFOUNDLAND: Canada, Geol. Survey, Mem. 290, 132 p., 2 maps (in pocket), Map 1057A, scale 1 in. to 2 mi., 18 figs., 10 pls., 1958, 84 refs.

Along the W. coast of Newfoundland is a discontinuous belt of ultrabasic and basic plutons, some 60 mi. long and up to 10 mi. wide. These plutons combine features of typical gravity-stratified sheets (e.g., the Bushveld complex) with those of the massive ultrabasic plutons characteristic of orogenic belts. A typical pluton section consists of banded serpentinized peridotite and dunite from 2 1/2 to 4 mi. thick, overlain by banded and massive gabbroic rocks of unknown thickness. Metamorphic rocks, ranging in composition from biotite phyllite, through amphibolite, to calcic hornfels, form contact aureoles along the unfaulted basal margins of the plutons. The metamorphism involved the addition of lime and magnesia to the country rocks. The ultrabasic zones show no systematic chemical variation (i.e. cryptic layering) with height in the intrusion. Banding in these rocks is interpreted as a flow structure comparable to that developed in ice by glacier flow. Troctolite, clinopyroxenite, feldspathic dunite, and other rock-types are interbanded along the gabbro-ultrabasic contact of the major plutons. Clinopyroxenite formed as a reaction product between ultrabasic and gabbroic magma. The overlying gabbroic rocks are intrusive into metavolcanic and pillowed volcanic rocks.

The concept is developed of a continuous series of layered pluton-types ranging in composition from gabbroic to ultrabasic with minor or no feldspathic layers. Their mode of origin is discussed with particular emphasis on modifications during contemporaneous and post-intrusion tectonism. The complex is a fossil remnant of a "plateau-type" intrusive that has been partly deformed in an orogenic belt. Asbestos,

chromite and Cu-Ni sulfides are associated with the intrusion. The chromite deposits occur in the upper part of the ultrabasic zones and are due to crystallization in a favorable (slightly feldspathic) chemical environment. --C. H. Smith.

1-1249. Bell, Henry, and W. C. Overstreet. RELATIONS AMONG SOME DIKES IN CABARRUS COUNTY, NORTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, [Bull.], Geol. Notes, v. 3, no. 2, p. 1-5, March-Apr. 1959, 5 refs.

Structural relations of dikes in the Isenhour quarry east of Concord, North Carolina, indicate six episodes of intrusive activity in these Piedmont-belt rocks. Large areas of dike swarms are probably the source of nearby acid and basic effusive volcanics and may explain the abundant volcanic material in the Carolina slate group. --M. Russell.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 1-1132; Stratigraphy 1-1141, 1-1155; Geophysics 1-1199.

1-1250. Friedman, Gerald M. IDENTIFICATION OF CARBONATE MINERALS BY STAINING METHODS: Jour. Sed. Petrology, v. 29, no. 1, p. 87-97, 2 figs., 4 tables, March 1959, 37 refs.

The visual differentiation between the different mineral constituents in a carbonate rock is fundamental to most studies of carbonate petrography, correlation and genesis. Differential staining of the constituent minerals provides a rapid means of recognizing the textural and compositional differences in the rock. This contrast between the component minerals can be accentuated by etching prior to staining. For routine identification of carbonate minerals, alizarine red S and Harris' hematoxylin stains are recommended, since they are fast, efficient, and dependable. For dolomitic rocks, the following 20 organic dyes provide a wide choice of colors for staining: Titan Yellow, 4(p-Nitrophenylazo)-1-naphthol,Quinalizarin, Alizarine Cyanine Green, Rhodamine "B" Base, Benzopurpin 4B, Congo Red, 1, 5 Diphenylcarbolhydrazide, Alizarine Red S, Barium Eosinate, Trypan Blue, Safranine O, Anthraquinone Green G (and Green G Base), Janus Green B, Bismarck Brown Y, Carmine Cert., Orange G, Neutral Red, Hastings Light Fast Violet, and Celutate Brilliant Blue. A combination of 2 different stains,alizarine red S and Feigl's solution, can be used in differentiating dolomite, calcite, aragonite, high-Mg calcite, gypsum, and anhydrite. Organic dyes stain calcite in acid solution and dolomite and magnesite in basic solution. The period of immersion in a staining solution, the acidity or alkalinity and temperature of the solution (i. e., whether the solution should be boiled or not) vary with the composition, porosity and grain size of the material to be studied. Because preparation and use of the solutions do not require laboratory facilities, the staining experiments may be conducted in any geological office on cores and cuttings for quick and accurate identification of these minerals.

Outlines of recommended staining procedures are given in tabular form. --Auth.

1-1251. Tasch, Paul. NEW METHOD FOR STUDY OF CALCI-PHOSPHATIC PELLETS: Jour. Sed. Petrology, v. 29, no. 1, p. 104-107, pl., March 1959, 7 refs.

Hydrofluoric acid treatment of opaque calci-phosphatic pellets renders them translucent. Details of internal structures, such as size, composition, configuration of nucleus, and number and thickness of growth bands, can readily be studied in any number of specimens. This facilitates comparison by horizon and locality, of genesis and growth of pellets, bottom conditions, and paleoecology in large pellet-populations. --Auth.

1-1252. Jonas, Edward C., and Thomas E. Brown. ANALYSIS OF INTERLAYER MIXTURES OF THREE CLAY MINERAL TYPES BY X-RAY DIFFRACTION: Jour. Sed. Petrology, v. 29, no. 1, p. 77-86, 6 figs., March 1959, 6 refs.

Much of the clay material in Recent and Tertiary sediments has been found to contain interlayer mixtures of 3 clay mineral types. An analytical method to determine the quantities of each clay mineral type in this kind of mixture involves gathering diffraction data from oriented aggregate specimens in equilibrium with 50% RH together with data from the specimen either after heating or solvating with ethylene glycol. The method provides precision commensurate with that of data which are obtained from this kind of clay material. --Auth.

1-1253. Baas Becking, L. G. M., and D. Moore. DENSITY DISTRIBUTION IN SEDIMENTS: Jour. Sed. Petrology, v. 29, no. 1, p. 47-55, 5 figs., 9 tables, March 1959, 3 refs.

The density of particles is a property which has not received adequate attention in recent studies of sediments. The distribution of densities in about 100 samples (chiefly sediments) was studied. Care was taken not to change the material by chemical means. The distribution are specific and reproducible for a given material. They confirm the evidence obtained microscopically that many sediments are made up of compound particles. In the samples studied very few particles with density greater than 3.4 or less than 1.4 were encountered. The method enables one to differentiate between younger and older sediments, as, during the aging of a sediment, organic matter combines (probably largely by physical forces) with mineral constituents, chiefly Fe compounds. Below a particle size of 400 microns there seems to be no pronounced correlation between particle size and composition. The surface charges which bind the components into a composite aggregate may change on oxidation or on reduction, as shown by the change in density distribution. The method provides a useful extension to the existing approach to the study of sediments and shows that particle size and particle shape may not be the most important characteristics of a sediment. --Auth.

1-1254. Pierson, Andrew L., III. A PHOTOMULTIPLIER PHOTOMETER FOR STUDYING QUARTZ GRAIN ORIENTATION: Jour. Sed. Petrology, v. 29, no. 1, p. 98-103, 3 illus., 3 diags., March 1959, ref.

In this article an improved photometer is described. The nonlinear illumination effects caused by a phototube having a cylindrical cathode and an axial wire anode have been eliminated in this new system by the use of an infrared sensitive photomultiplier tube with a flat photocathode. Because of this improvement, the preferential quartz grain orientation of many thin sections which could not be measured before can now be determined. --Auth.

1-1255. Flanagan, F. J., R. C. Kellagher, and William Lee Smith. **THE SLOTTED CONE SPLITTER:** Jour. Sed. Petrology, v. 29, no. 1, p. 108-115, 2 figs., 10 tables, March 1959, 7 refs.

A laboratory sample splitter was designed in the form of a 60° cone over those surface the entire sample passes. The split is captured by falling through pie-shaped slots on the surface of the cone. The splitter sampled an average of 13.5% of a crushed quartz monzonite, of which 80% passes a 140-mesh sieve.

The amount of sample captured is dependent on the particle size of the material sampled. A line of regression of the percent captured on size, and confidence limits for the estimate of the means of the amount split, are shown. Some qualities desirable in a splitter are enumerated, and the conformity of several splitters to these criteria is discussed. --Auth.

1-1256. Skolnick, Herbert. **AN INEXPENSIVE SAMPLE SPLITTER:** Jour. Sed. Petrology, v. 29, no. 1, p. 116-17, diag., table, March 1959.

Contains note on a sample splitter made by Western Gulf Oil Company using common materials found in any geologic laboratory. Diagram shows use of cut and uncut petrographic glass slides and assembly of the sample splitter. --A. C. Sangree.

1-1257. Harbaugh, John W. **SMALL SCALE CROSS-LAMINATION IN LIMESTONES:** Jour. Sed. Petrology, v. 29, no. 1, p. 30-37, 6 illus., March 1959, 4 refs.

Cross-stratification is a well-known structure in many detrital limestones. Several examples of very small scale cross-lamination in fine-grained limestones are described in the present paper, and these are cited as evidence of detrital origin. Cross-lamination in a limestone implies mechanical deposition of current transported particles and indicates that the limestone has not been precipitated in place.

Cross-lamination occurs on various scales in detrital limestones. In very fine-grained limestones, cross-laminae occur in "sets" of small dimensions, ranging in thickness from less than 1/25 of an inch to more than 1 in., and in length from 1 to 2 in. to 6 or 8 in. Small scale cross-laminae usually have angles of inclination from the horizontal of 20° or less. Frequently, small-scale ripple marks occur with cross-lamination. Cross-stratification is also common in coarse, mechanically-deposited limestones such as calcarenites and limestone conglomerates. The maximum angle of inclination of cross-strata is greater in coarse-grained limestones than in fine-grained limestones. In calcarenites and in limestone conglomerates, the angles of inclination may range as high as 35° or 40° from the horizontal.

Examples of small scale cross-laminations and of cross-bedding occurring in the upper portion of the Arbuckle limestone of S.-central Oklahoma are shown by negative peel prints and photographs in the present paper. --Auth.

1-1258. Minard, James P. **RECENT SAPROLITE:** Science, v. 129, no. 3357, p. 1206-1209, 3 illus., 2 maps, May 1, 1959, 4 refs.

The presence of a relatively thick occurrence of soft, crumbly gneissic saprolite in a predominantly glacier-scoured bedrock terrane [in the Cranberry Lake area, Sussex County, northern New Jersey] offers a possible means of determining the rate of weathering of the parent rock. Analysis of the supporting evidence indicates that the rock from which the saprolite formed must have been essentially unweathered when overridden by the ice. The supporting evidence includes (i) the position of the saprolite on a spur projecting into a glaciated valley and subject to severe glacial scouring; (ii) the lack of distortion or deformation of the gneissic layering at the contact with the overlying glacial till; and (iii) the absence of any comparable residual soil, with similar boundary conditions, elsewhere in the glacier-scoured bedrock terrane of this vicinity.

On the basis of this evidence [the author] believes that the saprolite formed as a result of weathering of the Pochuck gabbro gneiss of Precambrian age since the last withdrawal of the ice, somewhere between 14,000 to 15,000 and 18,000 to 20,000 years ago. --Auth. concl.

1-1259. Gravenor, C. P. **HEAVY MINERALS OF THE ATHABASCA SANDSTONE:** Alberta Soc. Petroleum Geologists, Jour. v. 7, no. 1, p. 1-7, illus., Jan. 1959, 6 refs; also pub. as: Research Council Alberta, Contr. Ser. no. 95.

Thin section and heavy mineral studies made on the sandstones found N. and S. of Lake Athabasca indicate that there are major differences between the Martin Lake arkose and the Athabasca sandstone. It is believed that the sandstones found at Fidler Point represent a remnant of the source rocks of the Athabasca sandstone. --Auth.

1-1260. Jones, Eugene L. **A STUDY OF GRAIN SIZE DISTRIBUTION AND HEAVY MINERAL COMPOSITION OF SANDS FROM THE WILCOX FORMATION OF SOUTH-CENTRAL ARKANSAS:** Compass, v. 36, no. 3, p. 222-26, 2 figs. incl. map, March 1959, 7 refs.

An investigation of the sands of the Wilcox formation [Eocene] of central Arkansas indicated that there was no significant change in either grain size or heavy mineral composition from base to top of the formation.

Diameters of grains and size distribution supports the hypothesis that the Wilcox formation in this area was deposited in a deltaic environment. Heavy minerals identified from the sands indicate that the source area was an exposed area or areas of sedimentary rocks. --Auth.

1-1261. Bisque, Ramon E., and John Lemish. **INSOLUBLE RESIDUE-MAGNESIUM CONTENT RELATIONSHIP OF CARBONATE ROCKS FROM THE DEVONIAN CEDAR VALLEY FORMATION:** Jour. Sed. Petrology, v. 29, no. 1, p. 73-76, 3 figs., March 1959, 6 refs.

The insoluble residue content of carbonate rocks

from several quarries in the Devonian Cedar Valley formation of eastern Iowa is shown to be related to the Mg content. The relationship of "soluble Fe" content to Mg content is plotted to demonstrate that a high soluble Fe content is found only in rocks with a high Mg content. The data presented may be of interest to persons concerned with the problem of dolomitization.--Auth.

1-1262. Carroll, Dorothy. SEDIMENTARY STUDIES IN THE MIDDLE RIVER DRAINAGE BASIN OF THE SHENANDOAH VALLEY OF VIRGINIA: U. S. Geol. Survey, Prof. Paper 314-F, p. 125-54, 10 illus. (2 in pocket), geol. maps scale 1 in. to 3 mi. and 1 in. to 1/2 mi., 12 tables, March 1959, 17 refs.

The Middle River in Augusta County, drains an area of about 370 sq. mi. in the southern part of the Shenandoah Valley of Virginia. The country rocks of this area are of several lithologic types - sandstone, shale, limestone, and dolomite - and range in age from Cambrian to Ordovician. The headwaters of the Middle River are in Cambrian rocks but important tributaries cut sandstone of Devonian age; the largest tributary, Christians Creek, flows across shale of Ordovician age for its entire length.

The Middle River drainage basin has residual, alluvial, and terrace and flood-plain soils. Residual soils are largely controlled by the underlying rocks and have developed profiles under podzolizing conditions in which acid leaching is the most important factor. The soils are silty with most of the material between 0.05 and 0.002 mm. in grain diameter. The average median grain diameter is 0.011 mm.

The alluvial soils have a grain-size distribution similar to that of the residual soils, but the alluvium coming directly from the Devonian sandstone areas is coarser, with a median grain diameter of 0.19 mm.

Soils of the terraces and high flood plains along the Middle River are now high enough above the river so that they are rarely flooded. These soils contain a greater amount of sand than do the residual or alluvial soils. The average median grain diameter is 0.04 mm.

Data derived from the figures for mechanical analyses show that all the soils are poorly sorted. None of the alluvial soils or terrace and high-plain soils are better sorted than the residual soils, with the exception of 2 sandy samples from the Little River.

Insoluble residues of representative bulk rock samples were obtained by treatment with hydrochloric acid. The insoluble-residue content of sandstone of the Chemung formation was about 90%, the Brailler shale about 85%, the Martinsburg shale 30-40%, the Lenoir and Mosheim limestones and the non-cherty limestone of the Beekmantown dolomite and the Elkbrook dolomite less than 5%, and the sandy dolomite of the Conochocheague limestone 40%. The actual weight of insoluble residue per acre-inch of rock ranged from about 1,000 lbs. for a limestone of the Beekmantown dolomite to more than 530,000 lbs. for sandstone of the Chemung formation.

The minerals in the insoluble residues of the country rocks and in the fine-sand fraction (0.10-0.05 mm. grain diameter) of the soils were identified under the microscope. The quantity of the heavy fractions (> sp. gr. 2.9) in each sample was determined, and the percentage of individual minerals in each heavy fraction was obtained by grain counts. The insoluble residues of the country rocks contain varying amounts of heavy minerals ranging from 10,630 lbs. per acre-inch of sandstone of the Chemung formation to about 1 1/2 oz. in the Elbrook dolomite. The minerals found are quartz, chert, orthoclase and plagioclase feldspars, microcline, shaly particles, and mica in the light fraction, and opaque grains (magnetite, ilmenite, and indefinite iron oxides), zircon, tourmaline, rutile, garnet, pyrite, kyanite, sphene, chloritoid, staurolite, anatase, zoisite, epidote, and amphibole in the heavy fractions. Apart from the opaque grains, zircon and tourmaline are the only minerals that are abundant. Both the sandy beds of the Conococheague limestone and the sandstone of the Chemung formation contain distinctive zircon and tourmaline varieties.

The minerals in the residual soils are essentially those which were identified in the insoluble residues of the rocks except that authigenic anatase is more abundant. The quantity of the heavy fraction is generally less than 1% by weight of the fine-sand fraction. Most of the alluvial soils contain a smaller percentage of heavy fraction than the residual soils, but there is considerable variation. Thus, the Middle River alluvium contains a larger percentage of heavy minerals than the alluvium of the Folly Mills Creek system and Christians Creek; the material carried from the sandstone of Devonian age may account for the larger quantities in the Middle River alluvium.

Heavy minerals in the soils of the terraces and high flood plains along the Middle River average 1.5% by weight of the fine sand. Samples collected nearest to the areas of sandstone of Devonian age contain from 1.25 to 2.8% heavy fraction. Zircon types in these soils suggest that the Devonian sandstone and not the sandy beds of the Conococheague limestone has been the main source of material. Similar evidence is provided by tourmaline.

Sand from the river-bed material of the Middle River and from several tributaries, together with a few samples from the North River, the South River, and the South Fork of the Shenandoah River, does not contain the same quantity of heavy minerals as the terrace and high flood-plain soils, but does resemble the residual soils in this respect. The average amount of heavy fraction in the sand of the Middle River system is 0.8% by weight; the average is raised by the large contribution from Buffalo Branch (2.25%). In contrast, the South Fork of the Shenandoah River, draining a different basin, contains about 6% heavy fraction in the fine sand. Mineralogically the bed material of the Middle River shows the influence of the rocks at the headwaters and of those through which it flows. Sand from the other rivers is mineralogically distinct from that of the Middle River. --Auth.

1-1263. Hansen, Kaj. SEDIMENTS FROM DANISH LAKES: Jour. Sed. Petrology, v. 29, no. 1, p. 38-46, 3 diags., 4 tables, March 1959, 28 refs.

The lake muds consist of 3 main components: 1) organic matter (humus), 2) minerogenic matter, 3) an inorganic, biogenic component (diatom frustules and calcium carbonate).

For the investigation of such sediments chemical analysis is necessary, since common petrographic methods are not sufficient. The organic matter is best expressed as loss on ignition, the inorganic biogenic components as alkali-soluble SiO_2 and calcium carbonate, and the minerogenic component as the difference between total SiO_2 and alkali-soluble SiO_2.

A distinction between 2 types of humus is of greatest importance. This can be expressed as the content of organic C and by the C/N ratio.

If the content of organic C is less than 50% and the C/N ratio less than 10, the humus is neutral, and if the content of organic C is higher than 50% and the

ratio C/N is higher than 10, the humus is acid.

Triangular diagrams indicate the relations between lake types and sediments, and are also used to illustrate the development of 2 Danish lakes. --Auth.

1-1264. Holtedahl, Hans. GEOLOGY AND PALEONTOLOGY OF NORWEGIAN SEA BOTTOM CORES: Jour. Sed. Petrology, v. 29, no. 1, p. 16-29, 6 figs., 3 tables, March 1959, 25 refs.

Nine sediment cores from the southeastern part of the Norwegian Sea, collected from depths between about 700 m. and 3000 m., have been examined. A gray, unsorted, sandy and pebbly clay, assumed to represent a glacial-marine sediment, is found to cover the surface of the sea bottom down to about 900 m. depth, and to continue underneath more recent sediments at greater depths. These latter include a 10-15 cm. thick top-layer of foraminiferal marl, with a $CaCO_3$ content reaching 48%.

An examination of the Foraminifera distribution of a core collected from a depth of about 3000 m. was carried out. The gray glacial clay is poor in Foraminifera, and the major part of the fauna consists of benthonic forms which live in lesser depths than where they are found, and therefore must be regarded as displaced. As this displaced fauna is restricted to the glacial-marine sediments of the core, it is assumed that it is transported to deep water by drifting ice. The low percentage of planktonic Foraminifera is thought to indicate rapid sedimentation of clastic material. The upper part of the glacial clay, which shows an increase in fineness upwards, also shows a marked decrease of the displaced benthonic fauna and a corresponding increase in the planktonic population. This is thought to indicate an amelioration of climate, with less ice-drift transportation, but still with rapid sedimentation of clastic material. The great increase in the Foraminifera population in the upper 30 cm. of the core, especially of planktonic forms, indicates further amelioration of climate, with clastic sedimentation having been of less importance. --Auth.

1-1265. Oinuma, Kaoru, Kazuo Kobayashi, and Toshio Sudo. CLAY MINERAL COMPOSITION OF SOME RECENT MARINE SEDIMENTS: Jour. Sed. Petrology, v. 29, no. 1, p. 56-63, illus., 7 tables, March 1959, 10 refs.

The mineralogical studies on recent marine sediments collected in the western Pacific Ocean were carried out by means of microscopic, thermal, chemical, and X-ray methods. The 38 specimens which were studied can be grouped into muds, blue muds, red clays and Globigerina oozes. Kinds of clay minerals were identified by X-ray, and their amounts were estimated quantitatively. Fragments of Foraminifera, diatoms, sponges, quartz, and black opaque materials consisting of magnetite or a black Mn material are found in the sandy part. Illite is the principal clay mineral in all the specimens except Globigerina oozes. Kaolinite and montmorillonite tend to be dominant in muds and blue muds (shallow-sea sediments). A chloritic mineral was also usually present in all the specimens except Globigerina oozes, and is relatively abundant in red clays (deep-sea sediments). The chloritic mineral under consideration commonly decomposes at a temperature below 600° C., and as low as 450°C. in some specimens. --Auth.

11. GEOHYDROLOGY

See also: Geochemistry 1-1219.

1-1266. Todd, D. K. ANNOTATED BIBLIOGRAPHY ON ARTIFICIAL RECHARGE OF GROUND WATER THROUGH 1954: U. S. Geol. Survey, Water-Supply Paper 1477, 115 p., 1959.

Artificial recharge, a means of increasing the amount of water that enters ground-water reservoirs, has been practiced in Europe for more than a century, and in southern California since 1895. Interest in the method has increased with the vastly expanded use of wells for water supply. Presented as a means for facilitating needed research on the subject, this bibliography covers reports and papers released up to and including 1954. --U. S. Geol. Survey.

1-1267. Hem, John D. STUDY AND INTERPRETATION OF THE CHEMICAL CHARACTERISTICS OF NATURAL WATER: U. S. Geol. Survey, Water-Supply Paper 1473, 269 p., 40 figs., 2 pls. (in pocket), 26 tables, Apr. 1959, 226 refs.

The chemical composition of natural waters is affected by the soluble products of rock weathering and decomposition. Chemical analyses of representative water samples help indicate the nature and importance of some of the environmental factors to which liquid water may be exposed in the hydrologic cycle.

The U. S. Geological Survey utilizes standardized procedures in water sampling, analysis, and reporting of results.

More than 50 constituents or properties may be determined in water analysis, but the usual analysis includes only those considered essential, in the light of the use to be made of the data, by the agency requesting the analysis. Specific conductance is an approximate indicator of concentration of dissolved solids. Hydrogen-ion concentration, reported as pH, depends on the extent of hydrolysis of certain anions and cations in solution. Solid residue remaining after evaporation is a direct measure of dissolved-solids concentration in water of normal composition. Silica may be present in water as a form of undissociated silicic acid but may hydrolize in some waters to increase the pH. Fe in the ferric form is nearly insoluble in normal water, but in the ferrous form 10 p. p. m. or more may be present. Mn is rarer in water than Fe, and, like Fe, may be brought into solution by activity of micro-organisms. Al is nearly insoluble in water in the pH range 5 to 9. Calcium carbonate is dissolved in water containing carbon dioxide and the resulting buffered system maintains the pH of most natural waters in the range 6 to 8. Mg is dissolved from igneous rock minerals and from carbonates, and when in solution is less readily precipitated than Ca. Na salts are very soluble, and the more highly mineralized waters generally are high in Na. In dilute waters which have been softened by base exchange or that have come from some types of siliceous igneous terranes, Na may constitute a high percentage of the total cations. K is less abundant in water than Na because it is reconstituted into insoluble secondary minerals that are formed in the process of weathering.

Although alkalinity in water is expressed in terms

of carbonate and bicarbonate ions, these values may actually represent not only the content of these ions but also all or parts of the effect of silicate, borate, and other anions which participate in hydrolysis. Acidity in water results both from hydrolysis involving cations, for example Fe or Al, and from the presence of free acids. Sulfate is the form in which S usually occurs in water. Weathering of sulfide-bearing rocks or direct solution of evaporate deposits may be important sources of sulfate. Chloride is present in many surface waters in amounts greater than could come from windblown sea salt in rain water. Some chloride is dissolved from rocks and some may be associated with connate and juvenile water. Fluoride concentrations in water are normally very low, but 30 p. p. m. or more may occur in waters from certain environments. Nitrate may be added to water by organic pollution, or leaching of fertilized soils, but in some waters the presence of nitrate is not easily explained. Phosphate may be contributed by organic pollution and may be introduced in the treatment of public supplies, but is rarely present in amounts over 1 p. p. m. B is a component of some very stable minerals and in trace concentrations is widespread in soils and waters.

Traces of heavy-metal cations are present in most waters. The amounts of Ti, Cr, Ni, Co, Cu, Sn, Pb, Zn, Cd, and Hg that are normally present are not known. Analyses rarely include these determinations except for mine waters and sources which are suspected of pollution. As and Se probably occur as anions and are of interest because of their toxic character, but rarely do unpolluted waters that are otherwise potable contain harmful amounts.

Nothing is known of the distribution of Be in natural water. Sr is very similar in chemical behavior to Ca and minor amounts probably occur in many waters. Ba has a highly insoluble sulfate, and only traces of Ba can be expected in waters where sulfate is present.

Li is probably common in amounts less than 1 p. p. m. in water. Very little information is available about Rb and Cs in water. Ammonium is found in water from some hot springs.

Many natural waters are weakly radioactive, owing to traces of natural radioactive disintegration products, especially Ra and Rn. Traces of U are common in natural waters.

Bromide and iodide are present in some natural brines and occur in trace amounts in other waters. Sulfite and thiosulfate are rarely found in natural water. Dissolved gases, especially O and carbon dioxide, are important in the action of water as a biologic and geologic agent. Hardness in water is of interest in connection with practical water use. The reaction of water toward soil in irrigated areas may be best predicted by use of the Na-adsorption ratio:

$$\frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Tabulation of more than 50 analyses of waters from various streams and underground aquifers shows the wide range of concentration of the common constituents of natural waters.

Water analyses may be compared and interpreted by various techniques. These techniques range from inspection of the data to more intensive comparisons using ratios of one constituent to another. Averages weighted by time or by discharge, and geochemical classifications made either mathematically or by graphic procedures are often used. The graphing systems in use include linear plots of 2 chemical variables, various types of bar graphs, radiating coordinates, multiple-axis pattern diagrams, linear pattern diagrams, subdivisions or distinctive shading of areas of fixed size or shape, and trilinear plots. Graphing procedures may be useful in showing relations of chemical variables to hydrologic variables, or to time. Such procedures include frequency diagrams, hydrographs, and rating curves. Areal study of water quality is aided by salinity profiles, and by symbol and isogram maps.

Quality of water is affected by many things besides mineral composition of the rock material associated with the water. When other factors are not of overshadowing magnitude, however, water from igneous terranes usually has a high proportion of dissolved silica. Water from resistate sediments is strongly influenced by solution of cementing material, water from hydrolyzates is often affected by connate salt and ion exchange, water from precipitates is usually porportionately high in calcium and magnesium bicarbonate, and water from evaporates is high in other dissolved salts. Waters may be considerably altered in composition by chemical precipitation, adsorption or ion exchange, reduction of sulfate, admixture of other waters, life processes of plants and animals, and activities of man.

Surface-water discharge can be measured by the behavior of injected "slugs" of salt and from the extent of dilution of continuous salt injection. These techniques can be applied in modified form to measure ground-water inflows to streams, rates of ground-water movement, and the volumes of underground water involved in mixtures of water from various sources.

Chemical quality standards for waters to be used for domestic, agricultural, and industrial purposes have been published by the U. S. Public Health Service, the Department of Agriculture and other agencies Water that does not meet the published standards is used in some places, but the users of such water should recognize potential difficulties and be prepared to meet them. --Auth.

1-1268. Mulikovskaya, Ye. P., and O. N. Tolstikhin. THE GERMANIUM CONTENT OF SOME SPRING WATERS IN KAMCHATKA: Geochemistry [Geokhimiya], 1958, no. 4, p. 493-96, table, 2 refs.

The Ge contents in waters of some springs of Kamchatka have been determined. The amounts found range from 1 to 25 micrograms per liter. Besides Ge, considerable amounts of boric acid and As have been detected. An interdependence between an increase of the Ge content and the rise of the water temperature is outlined. --Auth.

1- 1269. Hodson, Warren G. GEOLOGY AND GROUND-WATER RESOURCES OF MITCHELL COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 140, 132 p., 17 figs., 9 pls., maps, secs., 1959.

This report describes the geography, geology, and ground-water resources of Mitchell County, N. - central Kansas.

The rocks that crop out are sedimentary and range in age from Cretaceous to Recent. The oldest rocks exposed are sandstone, clay, and shale beds of the Dakota formation. They are overlain by a conformable sequence of Cretaceous marine rocks, classified, in ascending order, as the Graneros shale,

Greenhorn limestone, Carlile shale, and Fort Hays limestone member of the Niobrara formation. Unconsolidated continental deposits of fluviatile and eolian origin represent three stages of the Pleistocene Epoch. Pleistocene deposits include the Crete formation and Loveland formation of Illinoian age, Peoria formation of Wisconsinan age, and alluvial deposits of Wisconsinan and Recent ages. The surface geology is shown by a map, and cross sections illustrate the stratigraphic relations of the geologic formations.

Ground water in Mitchell County is recharged mainly by local precipitation; ground water is discharged mainly by effluent seepage to streams and by transpiration. Most municipal, industrial, domestic, and stock water supplies are obtained from wells. Moderate supplies of ground water are available from the alluvium and terrace deposits of Solomon valley, but ground-water supplies in the upland areas are small. A map shows the direction of movement of ground water in Solomon valley and the location of test holes and wells inventoried in Mitchell County.

In general, ground water in Mitchell County is hard but otherwise suitable for most uses. Waters from some wells, however, contained excessive amounts of certain constituents. The Dakota formation provides potable ground water only in the eastern part of the county; ground water from the Dakota in the western part is too mineralized for most uses.

The field data upon which this report is based are given in tables of 310 wells, logs of 60 test holes, and chemical analyses of waters from 53 representative wells. --From auth. abs.

1-1270. Walters, Kenneth L., and Charles K. Bayne. GEOLOGY AND GROUND-WATER RESOURCES OF CLAY COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 136, p. 1-106, 14 figs., 10 tables, 7 pls. (incl. geol. map, scale 1:56,000, ground-water map, scale 1:82,600, and secs., in pocket), Apr. 1959, 18 refs.

This report describes the geography, geology, and ground-water resources of Clay County, in N.-central Kansas. The field data, given in tables, include records of 143 wells, chemical analyses of water from 35 representative wells, logs of 28 test holes, and results of pumping (aquifer) tests. In addition, 110 holes were augered to determine the depth to water.

The rocks that crop out at the surface in Clay County are sedimentary and range in age from Permian to Recent. The oldest formation exposed in the county is the Barneston limestone. The Dakota formation, the youngest Cretaceous rock in the county, crops out over a large part of western and northern Clay County. The Permian and Cretaceous rocks are mantled in many places by unconsolidated continental deposits of fluviatile and eolian origin representating 4 stages of the Pleistocene epoch.

The unconsolidated sand and gravel deposits of Pleistocene age form the principal aquifer in the county. These deposits are thickest and most extensive in the valley of Republican River. The Dakota formation yields moderate quantities of water to wells in western and northern Clay County. The Barneston limestone yields small to moderate quantities of water to wells in eastern Clay County. Ground water in the area is recharged principally from local precipitation; underflow from adjacent areas contributes significantly, however. Ground water is discharged mainly by seepage into streams and by transpiration by plants. All municipal and industrial water supplies and most domestic and stock supplies are obtained from wells. Irrigation from wells is practiced extensively in the valley of Republican River. --From auth. abs.

1-1271. Giroux, P. R. SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN, 1957: Michigan, Geol. Survey Div., Water Supply Rept. no. 2, 79 p., 22 figs. incl. map, graphs, 2 tables, 1958.

Water-level fluctuations in 288 observation wells, observed in 1957 throughout Michigan, are summarized and interpretations are made for selected areas.

Statewide changes in natural storage were as follows: In the Southern Peninsula water levels were below average but rose to above-average levels by mid-year in response to heavy precipitation, except in the southwestern part where locally, cumulative deficiencies of precipitation during the 1952-57 period have caused levels to fall to record and near record low stages of the past decade. In the Northern Peninsula stages ranged from above average in the eastern part to below average in the western half.

In a number of urban areas where ground-water withdrawals are heavy, water levels generally continued in long-range declining trends.

Water levels in wells observed in the State respond to a variety of factors, including climatic conditions, pumpage, earthquakes, earthtides, artificial compressional forces, transpiration, and changes in regimen of surface drainage. --Auth.

1-1272. Vanlier, K. E., and Morris Deutsch. RECONNAISSANCE OF THE GROUND-WATER RESOURCES OF MACKINAC COUNTY, MICHIGAN: Michigan, Geol. Survey Div., Prog. Rept. no. 19, 82 p., 9 maps, 4 diags., graph, 7 tables, 1958, 47 refs.

The principal aquifers of Mackinac County, Mich., are limestone and dolomite strata of the Niagara series of Silurian age. Other important aquifers include sandstone units of Cambrian age; limestone, dolomite, and breccia of Late Silurian and Middle Devonian age; and sand and gravel deposits of Pleistocene age.

The water-bearing Munising sandstone of Cambrian age is tapped at depths of about 1,000 ft. by 2 wells in the northwestern part of the county, where, locally, water of good quality has not been obtained from shallower aquifers. Many wells tap the Burnt Bluff, Manistique, and Engadine formations of the Niagara series. These rocks form the bedrock surface over most of the county and are sources of relatively large quantities of fresh water. Wells in these rocks obtain water from solution openings along joints and bedding planes.

On the St. Ignace Peninsula, the Salina formation and the Mackinac breccia are important sources of ground water, although the rocks are of low permeability and yields are commonly small. Locally, these formations will not yield water in sufficient quantity even for domestic use. The Mackinac breccia and the St. Ignace and Bois Blanc formations are believed to be potential sources of water to wells on the islands in the Straits of Mackinac.

The glacial drift which mantles the bedrock formations is another important source or potential source of ground water over much of the county. In composition and thickness the drift mantle varies widely, however; in many areas it is thin, impermeable, or situated above the regional water table, and in such areas, of course, it is not a source of water.

Conditions are favorable for ground-water recharge

in large areas of the county where the surface is directly underlain by sand and gravel or permeable consolidated rocks.

Ground water in Mackinac County is used mainly for domestic supply. The total amount used is only a small fraction of the total available.

The quality of the ground water varies with the lithology and depth of the aquifers. Limestone and dolomite strata and the glacial drift deposits generally yield water of the calcium magnesium bicarbonate type. Water of the calcium sulfate type is present in the formations underlying the St. Ignace Peninsula which contain appreciable quantities of gypsum or are connected hydraulically to gypsum-bearing strata. Some of the sulfate waters are too highly mineralized for most uses. The deeply buried Cambrian sandstones produce fresh water which has higher concentrations of Na and chloride than water from shallow fresh-water aquifers. Highly mineralized water of the sodium chloride type has been produced from the Trenton and Black River limestones of Ordovician age. --Auth.

1-1273. Newport, Thomas G. GROUND-WATER RESOURCES OF THE LOWER NIOBRARA RIVER AND PONCA CREEK BASINS, NEBRASKA AND SOUTH DAKOTA: U. S. Geol. Survey, Water-Supply Paper 1460-G, 48 p., 7 figs., 3 pls. (incl. map in pocket), 5 tables, Apr. 1959, 38 refs.

This report describes the area in N.-central Nebraska and S.-central South Dakota drained by Ponca Creek and by the Niobrara River below Valentine, Nebraska.

The Dakota sandstone of Cretaceous age is the oldest formation in the area tapped by wells; it yields small to moderate quantities of highly mineralized water. Overlying the Dakota, in ascending order, are the following formations of Cretaceous age: the Graneros shale, Greenhorn limestone, Carlile shale, Niobrara formation, and Pierre shale. None of these are a source of water supply.

Two tertiary formations, the Brule and the Ogallala, are present in the area. The Brule is not a source of water, whereas the Ogallala yields small to moderately large quantities of a moderately hard calcium bicarbonate type water.

Unconsolidated deposits of Quaternary age mantle the Tertiary rocks in some areas. Where saturated, these sediments yield small to large amounts of water to wells. This water is of the calcium bicarbonate type, but is softer than that in the Ogallala.

The primary source of recharge to the Dakota sandstone in the report area is underflow from the W., and water discharges from the aquifer by underflow to the E.

The report also contains an appropriate bibliography, brief descriptions of the rocks in the area, a map showing contours of the water table, logs of test holes and wells, chemical analyses of ground and surface-water samples, and discharge records of large wells and representative small wells. --Auth.

1-1274. Newcomb, R. C. SOME PRELIMINARY NOTES ON GROUND WATER IN THE COLUMBIA RIVER BASALT: Northwest Sci., v. 33, no. 1, p. 1-18, 4 illus., geol. map, Feb. 1959, 12 refs.

The Columbia River basalt carries ground water by percolation, largely along tabular interflow zones of variable permeability and continuity. At various places the water occurs under perched, unconfined, and confined conditions; at some places it occurs under all 3 conditions at different depths. Both initial and tectonic structural features, such as inclination of the flows, anticlines and synclines, and jointing and faulting, have an important bearing on occurrences of ground water in the basalt. Recharge of the ground water is most effective in areas of substantial rainfall where gravel-bedded streams cross basalt flows inclined at low angles.

The basalt furnishes the main water supply for domestic and public needs and a substantial part of the water for irrigation and industry in the Columbia Plateau region. The chemical quality of the ground water is good but varies according to the geographic and geologic occurrence of the basalt rocks.

The ground water is developed by thousands of wells and springs. These fall into more or less distinct types according to their construction and the occurrence of the water. There is need for improvement in techniques of construction of wells tapping confined and perched water bodies.

Continued accumulation of basic geologic information is planned to guide in further development of the ground-water resources of the basalt. --Auth.

1-1275. Harbeck, G. Earl, Jr., G. E. Koberg, and G. H. Hughes. THE EFFECT OF THE ADDITION OF HEAT FROM A POWERPLANT ON THE THERMAL STRUCTURE AND EVAPORATION OF LAKE COLORADO CITY, TEXAS: U. S. Geol. Survey, Prof. Paper 272-B, 51 p., 22 figs., 2 pls., 11 tables, Apr. 1959, 16 refs.

Lake Colorado City, a reservoir in N.-central Texas is used as a source of cooling water for a thermal-electric powerplant. Evaporation from the lake was determined by the energy-budget method for the period July 1954 to Oct. 1955. Annual evaporation from Lake Colorado City was 93 in. of which 85 in. was natural evaporation, and 8 in. resulted from addition of heat to the lake by the powerplant.

Analyses indicate that if no heat had been added by the powerplant, the water-surface temperature would have been only 0.8° C. lower than that observed. The temperature rise is almost directly proportional to the heat input, so that doubling the quantity of heat added by the powerplant would raise the temperature an additional 0.8° C., if the volume of water in the reservoir was the same as in 1954-55. The temperature rise in a nearly empty reservoir, of course, would be much greater, and in a full reservoir, less.

The increase in evaporation from Lake Colorado City, when expressed as a volume, is directly proportional to the amount of heat added and is practically independent of reservoir contents. During 1954-55 the volume of forced evaporation resulting from the heat added by the powerplant, 910 acre-ft., was almost exactly the same as the volume of water diverted to Colorado City for municipal purposes.

The entire lake is being effectively utilized in disposing of heat. Water temperatures in the lower basin of the lake were higher in winter than those in the upper basin of the lake; no appreciable differences were observed in summer. Density differences between the 2 parts of the lake were very small at all times.

A comparison between average lake temperatures (as determined from the thermal surveys) and plant intake water temperatures indicates that water is withdrawn from all levels of the lake above the pump intakes. The average withdrawal temperature to be expected, if the amount of heat added by the powerplant is increased, probably will be about equal to

the anticipated surface temperature, which can be determined from graphs in the text. --Auth.

1-1276. King, Norman J. HYDROLOGIC DATA, WIND RIVER AND FIFTEEN MILE CREEK BASINS, WYOMING, 1947-54: U. S. Geol. Survey, Water-Supply Paper 1475-A, 44 p., 9 figs., 6 pls. (3 in pocket), 13 tables, Apr. 1959.

The collection of hydrologic data, measurement of physiographic features, and the study of drainage-channel characteristics believed to have an influence on erosion and sediment movement were begun in 1946 by the U. S. Geological Survey in 13 upland areas in the Wind River and Fifteen Mile Creek basins in Wyoming. The main objectives of these studies were: to obtain information needed to evaluate land-treatment practices under the Soil and Moisture Program of the Department of the Interior, to increase the background of basic data particularly from small drainage basins, and to complement streamflow and sediment investigations on the main streams. Observation procedures in the 13 sample areas, which represent different parts of the basins and tend to show the range of conditions common to the area, involved measurement of local precipitation and its effect on runoff and sediment movement as measured in stock-water and erosion-control reservoirs, instrumental surveys of channels and other topographic features, and examination of the geology and soil conditions of the study areas.

This report, in effect a progress report, contains the data collected during the period 1947-54. Owing to the general lack of high intensity storms and associated runoff within the project areas during that period, the data are insufficient to warrant conclusive interpretations. The report, therefore, is directed to presentation of original data with a description of methods and sufficient background to allow preliminary interpretation of the data presented. --Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-1068, 1-1069, 1-1070, 1-1073, 1-1085, 1-1089, 1-1098, 1-1102, 1-1108, 1-1109, 1-1110; Geochemistry 1-1218; Mineralogy 1-1237.

1-1277. Bidwell, Percy W. RAW MATERIALS. A STUDY OF AMERICAN POLICY: 403 p., 17 charts, 47 tables, New York, Harper & Brothers for the Council on Foreign Relations, 1958, approx. 350 refs.

This book deals with 2 questions: (1) how can we make sure that in a war emergency, our supplies of strategic materials will be adequate for defense production and civilian needs?; (2) what policies are best adapted to guarantee that in times of peace our economic growth will not be retarded by shortages of raw materials? Policy must consider the probable conditions of future supply. Is the free world running out of copper, lead, zinc, oil, and other industrial materials? Are we facing a period of sharply rising real costs? Will nationalistic policies raise obstacles to the expansion of production abroad and perhaps prevent access to their supplies? The underdeveloped countries are the principal targets of Soviet penetration. By what policies can the United States protect its interests in these areas?

The book describes the conditions of demand and supply, particularly as they have developed since World War II, and the principal features of national policy affecting production and trade in basic materials. It discusses our - and the free world's - requirements, present and future, and the conditions of supply. It suggests modifications in American policies to conform to technological advance and to the changing position of the United States in international affairs.

An important part of the book consists of a series of case studies on lead and zinc, copper, nickel, wool, rubber, oil and ferro-alloys. Each of these studies provides a background of economic information and describes and criticizes pertinent measures of government policy. --Auth.

1-1278. Ellis, R. M., and J. H. Blackwell. OPTIMUM PROSPECTING PLANS IN MINING EXPLORATION: Geophysics, v. 24, no. 2, p. 344-58, 6 figs., 2 tables, Apr. 1959, 3 refs.

The method of L. B. Slichter (1955) for optimizing prospecting plans in cases where geological information is meager has been extended to take account of a number of additional factors.

These include non-random distribution of ore in plan, non-random distribution in depth and finite thickness of ore bodies. Involved is the problem of overlap of ore bodies which appears to be of minor importance in most practical circumstances.

Evaluation of maximum profit ratios (or net profits) indicate that the new factors make significant changes from the results predicted by the simpler treatment and thereby justify the additional complication.

It appears that in many practical problems digital computing facilities could be used to advantage to accelerate problem solution. --Auth.

1-1279. Angino, Ernest E. COLLOIDAL DEPOSITION OF MINERALS - A BRIEF SURVEY: Compass, v. 36, no. 3, p. 152-26, March 1959, 6 refs.

Recently, much emphasis has been placed on the role of colloidal systems in the deposition of minerals. Colloidal deposition occurs in fresh and salt waters, surface and oxidized zones, supergene zones, and by hypogene action; however, the actual physiochemical processes involved are, as yet, unsolved problems. The ore at Cobalt, Ontario, is used to illustrate some of the phenomena involved in colloidal mineral deposition. --Auth.

1-1280. German, L. D. GEOCHEMICAL ZONATIONS IN THE BLYAVA DEPOSIT ON THE WESTERN SLOPE OF THE SOUTHERN URALS (IN RELATION TO MIGRATION OF ELEMENTS IN THE OXIDIZED ZONE AND TO DEVELOPMENT OF THE WEATHERED CRUST): Geochemistry [Geokhimiya], 1958, no. 4, p. 430-51, 8 secs., 11 refs.

The behavior of a number of chemical elements in the zone of oxidation, some fixation forms of these elements, and their distribution in the ore body and in the host rocks are considered. Separate groups of elements with similar behavior have been fixed. A definite trend in the migration processes of elements towards dissemination of ore components into the host rocks and separation of individual elements at certain distances from the ore bodies has been determined.

A supergene zonation has been ascertained for a number of chemical elements around the ore bodies and ore fields, both horizontal and vertical. The enriched zones either coexist or overlap one another. Geologists may use the studied sequence in the distribution of elements among supergene altered rocks as well as the mineral composition of zones for interpretations of new areas. The mineralogical-geochemical investigation gives to the prospecting geologist a rather precise idea of the location and depth of the ore-body occurrences and of their composition. --Auth.

1-1281. Bradbury, J. C. CREVICE ZINC-LEAD DEPOSITS OF NORTHWESTERN ILLINOIS: Illinois, State Geol. Survey, Rept. Inv. 210, 49 p., 11 figs., 6 pls. incl. 2 maps, 1959, 52 refs.

The shallow crevice Pb-Zn deposits of northwestern Illinois were an important source of Pb in the middle of the nineteenth century, but because of their small size and sporadic occurrence are not now generally regarded as economically valuable. An investigation was conducted to provide geological information that could be used to guide systematic prospecting and development and thereby renew interest in this neglected source of Pb and Zn.

Structural and mineralogical studies were made of all active and many abandoned mines and prospects. Evidence suggests that crevice mineralization can be expected to occur at depths below those formerly mined. In new areas, geophysical and, more especially, geochemical methods of prospecting can be used to locate mineralized crevices that can then be tested for ore deposits by drilling. Drilling techniques and equipment now under development should be helpful in crevice prospecting.

A map shows the locations of areas of Pb diggings and the directions of mineralized crevices. Information from old out-of-print publications is incorporated in summary form. --Auth.

1-1282. Lustig, Lawrence K., and Abraham Rosenzweig. MINERALOGY OF THE LONE STAR DEPOSIT, SANTA FE COUNTY, NEW MEXICO: Compass, v. 36, no. 3, p. 172-83, 5 illus., map, March 1959, 8 refs.

The Lone Star mine is located in La Bajada Canyon in the western part of Santa Fe County, about 42 mi. NE. of Albuquerque, New Mexico. The ore body at the mine occurs in the W. wall of a nearly vertical fault, and consists primarily of massive sulfides, dominantly marcasite and chalcopyrite. The Cieneguilla limburgite formation of Miocene age is the host rock of the district. It consists of thin limburgite flows and minor amounts of basaltic tuff and stream laid conglomerates. The important minerals of the ore body are: bornite, chalcopyrite, colusite, marcasite, pyrite, and some U minerals. A small dump, accumulated during the earlier mining operations, lies N. of the main shaft and has been considerably oxidized. These were recognized as products of oxidation: butlerite, copiapite, halotrichite, melanterite, S, and voltaite. The sulfide ore body is regarded as a hydrothermal replacement deposit with a probable age of late Pliocene to early Pleistocene. Photographs of polished sections of the ore are included. --Auth.

1-1283. Robinson, S. C. A GENETIC CLASSIFICATION OF CANADIAN URANIUM DEPOSITS: Can. Mineralogist, v. 6, pt. 2, p. 174-90, 2 tables, 1958, 25 refs.

A genetic classification of Canadian U occurrences is presented, together with lists of elements and minerals characteristic of each type. Of the 11 types listed, 3 are known to be economic in Canada and 2 are potential sources of U; 2 others have proved to be economic in the United States. Th and the rare earth elements are closely associated with U in many types of deposits but are conspicuously lacking in others. U minerals found in each type of deposit are discussed together with other minerals whose spatial distribution is the same as that of U. It is concluded that although the major factor controlling the type of deposit is the genetic process, marked differences in type may also be due to structures in, and type of, host rock. For many deposits there is evidence of more than one period of mineralization; in an extreme case, the original deposit of pitchblende was formed 1.5×10^9 years before the latest period of hypogene mineralization in the same vein. --Auth.

1-1284. U. S. Geological Survey. GEOLOGIC INVESTIGATIONS OF RADIOACTIVE DEPOSITS. SEMIANNUAL PROGRESS REPORT FOR DECEMBER 1, 1956 TO MAY 31, 1957: U. S. Atomic Energy Comm., [Pub.], TEI-690, 2 v., 571 p., 117 figs., 45 tables, July 1957, pub. 1959, refs.

During the report period, geologic mapping was undertaken in the Colorado Plateau region in Bull Canyon, Slick Rock, Uravan, western San Juan and Ute Mountains areas, Colorado; Sage Plain, La Sal Creek, and Lisbon Valley areas, Utah-Colorado; Moab-Inter-River, Orange and Circle Cliffs, San Rafael Swell, Elk Ridge, Abajo Mountains, and E. Vermillion Cliffs areas, Utah; and Grants and Laguna areas, New Mexico. Brief reports on selected topics taken from geologic investigations in these areas are given. Geologic mapping in the Black Hills, South Dakota and Wyoming; the southern Powder River basin, Gas Hills, and Hiland-Clarkson Hill areas, Colorado; Thomas Range, Utah; and Tucumcari-Sabinoso area, New Mexico, is described. Activities involved in the geologic mapping of Turtle Lake quadrangle, Washington; Jarbridge quadrangle, Nevada; Mauch Chunk area, Pennsylvania; and phosphate deposits, especially their "leached zones," in Florida are outlined. Drilling on the Colorado Plateau from 1947 to 1956 is summarized, and ore reserves discovered as a result are analyzed.

Coincidence of U occurrences with certain stratigraphic features in the major U-producing regions has permitted investigations of Triassic strata, Entrada sandstone of the San Rafael group, regional synthesis, localization and origin of U-V deposits, and diatremes on the Colorado Plateau. Petrographic analyses of some sandstone beds in the Inyan Kara group and associated rocks are outlined, as are those of the Dripping Spring quartzite. Recounted are findings from the regional synthesis of eastern Montana and the Dakotas and general research and resource studies. Progress in study of Permian strata of N. Texas and S. Oklahoma and Pennsylvanian sediments in the Midcontinent, and in reconnaissance for U in Alaska is reported.

Regional geophysical studies of the Colorado Plateau and Texas Gulf Coastal Plain, gamma-ray logging studies, development and maintenance of radiation-detection equipment, correlations of airborne radioactivity data and areal geology, and other geophysical investigations are developed. A brief resumé of geochemical, botanical, and mineralogical investigations

is presented. Analytical services and research on techniques in the fields of radioactivity, spectroscopy, chemistry, and mineralogy are described.

Physical behavior of Rn, absorption and scattering of gamma radiation, Rn and He studies, U in natural waters, organic geochemistry of U, distribution of U in igneous rocks, synthesis and solution chemistry of U-bearing minerals, stable isotopes, nuclear geology, geochronology, isotope studies of Pb, natural radioactivity of the atmosphere, thermoluminescence of radioactive minerals, geology and geochemistry of Th, and geologic thermometry of radioactive minerals are projects under study in the trace-elements program which are outlined in this report. --G. E. Denegar.

1-1285. U. S. Geological Survey. GEOLOGIC INVESTIGATIONS OF RADIOACTIVE DEPOSITS. SEMIANNUAL PROGRESS REPORT FOR DECEMBER 1, 1957 TO MAY 31, 1958: U. S. Atomic Energy Comm., [Pub.] TEI-740, 320 p., 55 figs., 35 tables, June 1958, pub. 1959, refs.

During the report period, geologic mapping was undertaken in the Colorado Plateau region in the Slick Rock, Klondike Ridge, and western San Juan and Ute mountains areas, Colorado; Lisbon Valley area, Utah-Colorado; Moab-Inter-River, Orange and Circle Cliffs, and Abajo Mountains area, Utah; and Grants and Laguna areas, New Mexico. Brief reports on selected topics taken from geological investigations in these areas are given. Geologic mapping in the Central region covered parts of the Black Hills, North and South Dakota; the Gas Hills and Hiland areas, Wyoming; the Maybell-Lay area, Colorado; and the Tucumcari-Sabinoso area, New Mexico. Brief accounts of activities and findings in these areas are presented. The Turtle Lake quadrangle, Washington, is described, as is the geology of the Mauch Chunk area, Pennsylvania.

Compilation of data on Paleozoic and Mesozoic rocks of the Colorado Plateau region continued, with emphasis on Triassic lithology, Entrada sandstone of the San Rafael group, and diatremes. Other geologic topical studies include investigations of Dripping Spring quartzite, Inyan Kara group, and Morrison formation; regional synthesis of eastern Montana and the Dakotas; radioactivity of Devonian and Mississippian black shales of the Midcontinent region; reconnaissance for U in Alaska; and U in organic substances in alpine meadows of California.

Geophysical investigations comprised regional studies in the Colorado Plateau and Texas Gulf Coastal Plain, physical properties of ore and host rock, development and maintenance of radiation-detection equipment, gamma-ray logging studies, and correlation of airborne radioactivity data and areal geology. Distribution of elements studies, botanical and geochemical research, mineralogy and geochemistry of U deposits in Karnes County, Texas, and mineralogical and radioactivity investigations are described. Accounts of analytical services rendered and progress on techniques research are given.

Projects under study in the trace elements research program include: physical behavior of Rn, absorption and scattering of gamma-rays, organic geochemistry of U, distribution of U in igneous complexes, synthesis and solution chemistry of U-bearing minerals, stable isotope analysis, nuclear geology, geochronology, isotope geology of Pb, natural radioactivity of the atmosphere, thermoluminescence of radioactive materials, geology and geochemistry of Th, geologic thermometry of radioactive materials, and crystallography of U and associated minerals. --G. E. Denegar.

1-1286. Granger, Harry C., and Robert B. Raup. URANIUM DEPOSITS IN THE DRIPPING SPRING QUARTZITE, GILA COUNTY, ARIZONA: U. S. Geol. Survey, Bull. 1046-P, p. 415-86, 23 illus. (4 in pocket), geol. maps scale 1 in. to 1500 ft. and 1 in. to 1000 ft., 4 tables, Apr. 1959, 34 refs.

The Dripping Spring is a formation in the Precambrian Apache group that crops out extensively in southeastern Arizona. Nearly all the U deposits in the Dripping Spring are in Gila County. This paper is primarily a progress report on studies designed to accumulate geologic data that will aid in the understanding of the localization and the genesis of U deposits in the Dripping Spring quartzite.

The Apache group consists of the Scanlan conglomerate, Pioneer formation, Barnes conglomerate, Dripping Spring quartzite, and Mescal limestone. It is underlain by older Precambrian basement rocks, overlain by basalt and a succession of Paleozoic and younger sedimentary rocks, and extensively intruded by diabase.

The Dripping Spring and Mescal are locally metamorphosed adjacent to diabase bodies: siltstone in these rocks is recrystallized to hornfels, siliceous limestone in the Mescal is converted to serpentine and asbestos, and impure limestone and mudstone in the Mescal are replaced by Fe ore and amphibole.

Rocks of the Apache group in the northern part of Gila County have been strongly affected by structural features associated with intrusion of diabase and also by faults and strong joint systems that are later than the diabase. One strong joint system consists of fractures that strike about N. 20° E. and N. 70° W., parallel to the principal trends of the U ore bodies.

U in the Dripping Spring quartzite was originally discovered in 1950. By the summer of 1955 nearly a hundred deposits were known. All these deposits are in the silty upper member of the Dripping Spring, and most of them are between 100 and 130 ft. above the base of the member. Both normal siltstone and siltstone recrystallized to hornfels adjacent to diabase are favorable host rocks.

The longest dimension of nearly all the deposits trends either NNE. or WNW. The intermediate dimension is less than 20 ft. in most deposits; this dimension ordinarily is vertical, but in some deposits it is parallel to the bedding. The short dimension is commonly less than 5 ft.

Uraninite is the primary U mineral in deposits near diabase. For the most part the host rock for these deposits is feldspar-rich siltstone recrystallized to hornfels. In unmetamorphosed siltstone the primary U occurs in uraninite and in several unidentified forms.

Pyrite, marcasite, chalcopyrite, and, more rarely, galena and sphalerite are associated with nearly all the deposits. Pyrrhotite and molybdenite have been recognized only in deposits near or in metamorphosed siltstone and diabase.

Most of the secondary U minerals in weathered parts of the deposits are phosphates and silicates. They are associated with limonite, gypsum, secondary Cu minerals, and hyalite.

The primary deposits are found along favorable beds and fractures near diabase contacts. They are parallel to structural features that have been characteristic of the Dripping Spring throughout its history.

The U deposits are believed to be genetically

related to the diabase. Present evidence suggests that the deposits may have been formed by U-bearing hydrothermal solutions emitted by the diabase at a late stage in its differentiation. --Auth.

1-1287. Klemic, Harry, Allen Van Heyl, Jr., A. R. Taylor, and Jerome Stone. RADIOACTIVE RARE-EARTH DEPOSIT AT SCRUB OAKS MINE, MORRIS COUNTY, NEW JERSEY: U. S. Geol. Survey, Bull. 1082-B, 38 p., 7 illus. (1 in pocket), 4 tables, Apr. 1959, 7 refs.

A deposit of rare-earth minerals in the Scrub Oaks Fe mine ... was mapped and sampled in 1955. The rare-earth minerals are mainly in coarse-grained magnetite ore and in pegmatite adjacent to it. Discrete bodies of rare-earth-bearing magnetite ore apparently follow the plunge of the main magnetite ore body at the N. end of the mine. Radioactivity of the ore containing rare earths is about 0.2 to 0.6 milliroentgens per hour.

The principal minerals of the deposit are quartz, magnetite, hematite, albite-oligoclase, perthite, and antiperthite. Xenotime and doverite aggregates and bastnaesite with intermixed leucoxene are the most abundant rare-earth minerals, and zircon, sphene, chevkinite, apatite, and monazite are of minor abundance in the ore. The rare-earth elements are partly differentiated into Ce-rich bastnaesite, chevkinite, and monazite, and Y-rich xenotime and doverite. Apatite, zircon, and sphene contain both Ce and Y group earths.

Eleven samples of radioactive ore and rock average 0.009% U, 0.062% Th, 1.51% combined rare-earth oxides including yttrium oxide and 24.8% Fe. Scatter diagrams of sample data show a direct correlation between equivalent U, Th, and combined rare-earth oxides. Both Ce- and Y-group earths are abundant in the rare-earth minerals.

Radioactive magnetite ore containing rare-earth minerals probably formed as a variant of the magnetite mineralization that produced the main Fe ore of the Scrub Oaks deposit. The rare-earth minerals and the Fe ore were deposited contemporaneously. Zircon crystals, probably deposited at the same time, have been determined by the Larsen method to be about 550 and 600 million years old (late Precambrian age).

U, Th, and rare-earth elements are potential byproducts of Fe in the coarse-grained magnetite ore. --Auth.

1-1288. Muan, Arnulf. FROM IRON OXIDE TO METALLIC IRON: Mineral Industries, v. 28, no. 7, p. 1, 4-6, 8, 8 figs., Apr. 1959, 8 refs.

Intensive efforts are presently being made to develop new methods for producing iron from its ores. Most prominent among these methods is the so-called direct reduction process to yield a product commonly referred to as sponge iron. The science and technology of metallurgy have now advanced to the stage where new processes can be examined critically from a scientific point of view before practical operations are initiated. Equilibrium relations existing among metallic iron and iron oxides are well understood. Diagrams are presented to show relations of O_2 pressure and temperature required for coexistence of 2 condensed phases in univariant equilibria. Diagrams of greater practical value are obtained by combining these data with those available on the dissociation of H_2O and of CO_2. From this are constructed diagrams illustrating conditions for reduction of iron oxides to metallic iron by the commercially important reducing agents H_2O and CO.

The kinetics of the reduction are complicated, but are now fairly well understood on the basis of modern concepts of solid state chemistry. The reduction of Fe_3O_4 by a gas (CO or H_2) takes place as a topochemical reaction in which zones of metallic iron and wustite are formed approximately parallel to the outlines of the original sample. The primary rate-determining factor is the diffusion of cations (Fe^{2+}) and electrons through the defect structure of the wustite layer. --Auth.

1-1289. Gordon, MacKenzie, Jr., Joshua I. Tracey, Jr., and Miller W. Ellis. GEOLOGY OF THE ARKANSAS BAUXITE REGION: U. S. Geol. Survey, Prof. Paper 299, 268 p., 102 illus. (33 in separate cover), geol. and subsurface maps, scale 1:31,680, 15 tables, Apr. 1959, 197 refs.

The Arkansas bauxite region lies near the center of the State in Pulaski and Saline counties. It is irregular in outline, covering about 275 sq. mi. and is elongate in a northeasterly direction. Bauxite deposits in the region can be grouped into 2 principal districts, one in Pulaski County about 5 mi. S. of Little Rock, and the other, more important commercially, about 25 mi. SW. in Saline County.

The bauxite deposits lie entirely within the Gulf Coastal Plain province a short distance SE. of its boundary with the Interior Highlands province. The surface rocks in this part of the Gulf Coastal Plain are early Tertiary sand and clay. The topography consists of gently rolling hills that are less than 200 ft. above the valleys. The maximum relief is about 340 ft. The lowest point, on Fourche Creek, is about 240 ft. above sea level, and the highest altitude, on Alexander Mountain 15 mi. to the SW., is 580 ft.

The rocks underlying the Interior Highlands province at the NE. edge of the bauxite region are folded sandstone and shale beds of Paleozoic age. N. and NE. of Little Rock the topography consists of flat to rounded ridges and broad to narrow valleys. This area merges southwestward into a region consisting of prominent straight ridges and narrow valleys, generally trending northwestward. The Paleozoic rocks generally are increasingly old and more tightly folded to the SW. The line of demarcation between the Interior Highlands and Gulf Coastal Plain physiographic provinces is the contact between the hard rocks of Paleozoic age and the soft beds of Tertiary age to the SE.

The Coastal Plain includes marine and nonmarine strata of Paleocene and Eocene age, gravel of late Tertiary and Quaternary age, and terrace deposits and alluvium of Quaternary age. The Tertiary sediments rest unconformably on rocks of Paleozoic age and on intrusive masses of nepheline syenite of probable Late Cretaceous age. These strata lap over and around the resistant masses, particularly the nepheline syenite, parts of which remained exposed as hills throughout much of their history. The Tertiary strata generally strike northeastward and dip gently southeastward, although this has been modified locally by compaction.

The Midway group, which is divided into 2 formations, consists of dominantly marine sediments of Paleocene age. The lower one, of interbedded gray marly clay and sandy limestone containing local conglomerate, is the Kincaid formation. The upper one, consisting essentially of blue-black or dark-gray clay, somewhat calcareous at the base, is the

Wills Point formation.

The sediments of Eocene age are dominantly nonmarine and overlie unconformably those of the Midway group. Most of these continental beds have been referred to the Wilcox group, which in this area is divided into 3 formations. The lowest is the Berger, which consists mainly of interbedded gray silty clay, greenish-gray sand, and lignite. Fringing the buried nepheline syenite hills, a facies of weathered detrital kaolinitic clay that contains many bauxite bodies is included in the Berger. The overlying Saline formation includes a lower member of chocolate-brown silty to sandy clay and an upper member of red ferruginous sand. Along the upland of Paleozoic rocks a gravel and sand facies is present in the Saline. The uppermost of the Wilcox formations is the Detonti sand, a gray to tan sand containing scattered clay beds. In the southwestern part of the bauxite region an extensive bed of lignite occurs at the base of the sand.

Later Eocene strata are represented locally by nonmarine and marine beds, mostly sand, clay, and some lignite, of the Claiborne and Jackson groups. It is possible that regional studies will later prove that the Wilcox in the Arkansas bauxite region should be restricted to the Berger formation and that the Saline formation and Detonti sand should be transferred to the Claiborne group. The writers are following usage in the present classification of the rocks.

The outcrops of the nepheline syenite and related igneous rocks associated with the bauxite in this region are the more elevated parts of cupolas of a batholith of feldspathoidal igneous rock. These igneous rocks were intruded into sediments of Paleozoic age, the youngest of which are probably Pennsylvanian. Subsequent erosion exposed parts of the igneous mass, some to prolonged weathering, and some to be buried by sediments of Paleocene and Eocene time. Two coarse-grained varieties of the nepheline syenite are the principal source rocks of most of the bauxite. These are the nepheline syenite that is locally known as "gray granite," and pulaskite, the so-called blue granite.

Bauxite in the region occurs as discontinuous blanketlike deposits over the weathered surface of the nepheline syenite hills and as lenticular deposits resting unconformably on the gently sloping surface of the Wills Point formation near the break in slope where it comes in contact with the igneous rock. Secondary deposits similarly tongue into stratigraphically higher units. Bauxite formed almost entirely from the nepheline syenite rocks in place or from detritus derived from these rocks. The deposits may be classified into 4 types.

Type 1. Residual deposits on the upper slopes of partly buried nepheline syenite hills. These deposits have a lower zone preserving the granitic texture of the original rock, and an upper concretionary zone.

Type 2. Deposits in the bauxite-kaolin facies of the Berger formation. This facies lie on lower slopes which are cut into the Wills Point formation (Paleocene) and forms part of the edge of the Berger formation (lower Eocene). The deposits have a lower zone locally preserving fragmental clay textures, a thick concretionary zone above, and commonly a siliceous "hardcap" upslope. They grade into kaolin laterally and vertically.

Type 3. Bedded deposits of the Berger formation. These alluvial deposits are composed of stratified, sorted, or crossbedded pebbles, pisolites, and grains of bauxite. They characteristically truncate, overlie, and fill channels in type 2 deposits.

Type 4. Conglomerate deposits at or near the base of the Saline formation. They consist of rubble deposits of large and small fragments of bauxite and clay largely derived from type 1 deposits and generally lie a short distance downslope from the type 1 deposits.

Types 1 and 2 deposits are the most extensive and are almost equally important commercially. Types 3 and 4 have provided ore in a number of mines, but neither is of primary commercial importance.

In Arkansas, the type 1 bauxite originated directly from the nepheline syenite by subaerial weathering under certain restricted physical-chemical conditions. The lower part called granitic bauxite or "sponge ore" shows a striking similarity in texture to the nepheline syenite. Pseudomorphs of microcrystalline gibbsite after feldspar are common and are characterized by large relict crystals marked by groups of parallel linear cavities. The upper part has acquired a pisolitic texture through redistribution of gibbsite. The kaolin between the bauxite and nepheline syenite did not form as an intermediate stage in this process, but was derived from the igneous rock by later weathering when conditions favored the formation of kaolin.

Downslope, the type 2 deposits formed in place by the subaerial weathering of a colluvial detritus washed down from the nepheline syenite. The type 3 and 4 deposits originated from the other two largely by mechanical erosion and deposition somewhat down the slope.

The primary mineral in Arkansas bauxite is gibbsite, aluminum trihydrate. The chief impurities are silica in the form of kaolinite and sand, and Fe in the form of siderite, hematite, goethite, magnetite, and pyrite. Boehmite occurs rarely. The Ti minerals, ilmenite, sphene, anatase, and rutile, occur in minor amounts.

Spectrographic study indicated a significant concentration of Ga and Nb in the bauxite compared with the nepheline syenite. This concentration is in accordance with the ionic potential of these elements. It also showed a concentration of Cr, Cu, Mo, Zr, Ti, Sc, V, Be, Mn, Y, and Pb; and a depletion of Sr, La, Ba, Ca, and Mg.

Bauxite was first identified in Arkansas in 1887 by J. C. Branner, then State Geologist. In order to stimulate production of the ore, a description of the rock was published in 1891. However, bauxite mining was still in its infancy in the United States and remained centered in Georgia and Alabama until 1898 when commercial production in Arkansas began. By 1903, however, Arkansas had become the leading producer in the United States, a position never since relinquished. The largest annual production from the region was 7,053,028 long tons in 1943. Total estimated production of crude bauxite from 1896 through 1949 is about 32 million long tons.

Open-pit mining is the preferred method in the region and, until the late twenties, was the only one used. Before 1927, the greatest amount of overburden stripped to reach ore was 80 ft. Owing to exhaustion of most of the shallow ore and costs of stripping the deeper deposits, several underground-mining methods were introduced. In the late twenties and early thirties about 60% of the bauxite production came from the underground mines. Most recent improvement of earth-moving equipment and the necessity during World War II for exposing the largest volume of ore in the shortest possible time led to a renewal of strip-mining on a large scale. During the forties, by far the greater proportion of bauxite came from open-pit mines.

Reserves in the region in 1950 are estimated at about 70.7 million long tons averaging 50% alumina and 9% silica, but assuming no cutoff on Fe. Of this total, about 62.6 million tons occurs in Saline County, and 8.1 million tons in Pulaski County. Most of the ore remaining in Pulaski County occurs in deposits containing less than 500,000 tons. In Saline County, however, a major part of the reserves is in deposits that contain more than a million tons in place. --Auth.

1-1290. Gillson, Joseph L. SAND DEPOSITS OF TITANIUM MINERALS: Mining Engineering, v. 11, no. 4, p. 421-29, 9 maps, Apr. 1959, 26 refs.

Historically, rock deposits and sand deposits of Ti minerals came into production about the same time. Beach deposits of heavy minerals in Brazil and India were worked for monazite about the time of the turn of the century, but since at that time there was no market for the Ti minerals, these were thrown away. The rock rutile deposits at Roseland, Virginia, were worked to supply rutile for Ti chemicals and for coloring ceramics long before there was a Ti pigment business. The pigment industry started about the mid-1920's, both in Europe and the United States, and almost simultaneously the rock deposits in southern Norway and beach deposits at Ponte Vedra Beach near Jacksonville [Florida] were worked for their Ti content. Since those days, production from both types of deposits has continued to grow at a rapid rate, and many deposits of both types have been found, and reserves have grown to very large figures. In total tonnage of reserves, there is no doubt that the rock deposits are far ahead of the sand deposits, but nevertheless there is a very large tonnage of commercial sands available. It is the quality of the Ti mineral in the sand deposits and the relatively lower cost of operation of sand deposits that have kept them abreast, at least in annual tonnage produced, with the rock deposits. --Auth.

1-1291. Bassett, A. M., D. H. Kupfer, and F. C. Barstow. CORE LOGS FROM BRISTOL, CADIZ, AND DANBY DRY LAKES, SAN BERNARDINO COUNTY, CALIFORNIA: U. S. Geol. Survey, Bull. 1045-D, p. 97-138, 2 illus. (1 in pocket), Apr. 1959, 15 refs.

Detailed core logs of 4 holes drilled in . . . southeastern San Bernardino County, Calif., are given in the present report. The 3 dry lakes lie in a chain of basins having a drainage area of 4,000 sq. mi. which is made up of alluvial slopes and of mountains composed of granitic, metamorphic, and volcanic rocks. Rainfall in the basins averages less than 3 in. annually.

In Bristol Dry Lake, 1 hole was drilled to a depth of 1,007 ft., and penetrated layers of dense clay alternating with salt. About 40% of the recovered core is halite, ranging from scattered crystals in clay to massive beds more than 8 ft. thick. In Cadiz Dry Lake, 1 hole was drilled to a depth of 500 ft. The core is composed of clay, silt, and sand, with scattered gypsum crystals in small quantities, and a single salt layer, 1 ft. thick, lying about 9 ft. below the surface. Bedding in this core is horizontal down to a fracture at a depth of about 256 ft.; from there to the bottom, the dip increases gradually to a maximum of 35°. In Danby Dry Lake, 2 holes were drilled, the first and more northerly one to a depth of 880 ft., and the southerly one to a depth of 460 ft. Both cores are composed of clastic sediments ranging from clay to coarse sand with fine sand the most abundant. Crystalline gypsum in silt occurs between 310 and 520 ft. in the northern hole and between 278 and 334 ft. in the southern hole. The northern hole was drilled in gravel for the last 20 ft. No salt beds were cut in either of the Danby holes despite the occurrence of commercial salt deposits elsewhere on the surface of the playa. Correlation of sediments between any of these cores, even between those from the same basin, is difficult and seldom convincing.

Fossils were found in the Cadiz core and in both Danby cores. The most abundant fossils are Chara, the calcified seeds of the Charophyta algae. Foraminifers, ostracodes, gastropods, pelecypods, and barnacles, in order of decreasing abundance, occur at rare intervals in these 3 cores. --Auth.

1-1292. Hardin, George C., Jr., and Robert D. Trace. GEOLOGY AND FLUORSPAR DEPOSITS OF THE BIG FOUR FAULT SYSTEM, CRITTENDEN COUNTY, KENTUCKY: U. S. Geol. Survey, Bull. 1042-S, p. 699-724, 4 illus. (2 in pocket), geol. map scale 1:2,400, Apr. 1959, 2 refs.

The Big Four fault system, near Marion, Kentucky, in the Kentucky-Illinois fluorspar district, is a complex northeastward-trending system of steeply dipping normal faults. Mining activity started in the area at the LaRue mine in 1874, and as of January 1945 about 35,000 tons of metallurgical grade fluorspar had been produced; most of this was from the Big Four mine. A small quantity of Pb and Zn ore also has been produced.

The deposits are localized along the faults which displace nearly flat-laying shales, sandstones, and limestones of the Meramec and Chester series of Mississippian age and the Caseyville sandstone of early Pennsylvanian age. Displacements in the area mapped range from a few feet to more than 1,500 ft.

Detailed geologic mapping of the surface and data from underground workings have revealed at least 19 faults. Only a few of these faults are known to contain economic deposits of fluorspar.

The most abundant vein minerals are fluorite and calcite with subordinate quantities of sphalerite, galena, smithsonite, pyromorphite, anglesite, cerussite, marcasite, and quartz. More than half of the mined fluorspar came from veins composed mainly of fluorite and calcite. The ore bodies are the result of fissure filling with some replacement of the early vein material and wallrock. Residual concentrations of high-grade fluorspar in the overburden along faults also have yielded considerable quantities of "gravel" fluorspar. --Auth.

1-1293. Mertie, John B., Jr. QUARTZ CRYSTAL DEPOSITS OF SOUTHWESTERN VIRGINIA AND WESTERN NORTH CAROLINA: U. S. Geol. Survey, Bull. 1072-D, p. 233-398, 6 illus., Apr. 1959, 8 refs.

The quartz deposits of southwestern Virginia and western North Carolina were investigated by the U. S. Geological Survey during 11 months of 1943. In Virginia, 89 informants and owners of quartz or deposits of quartz were visited, and 206 were visited in North Carolina.

Most of these deposits are on the plateau that forms the northwestern flank of the Blue Ridge, but others occur in the Piedmont province, about 30 mi. SE. of the Blue Ridge. Three general sites are known in this Plateau province, and 2 in the Piedmont province. As it is impractical to describe all these deposits,

certain ones have been selected that illustrate geologic, economic, or other features of special interest.

All the quartz deposits are in areas where the bedrock is dominantly schist or gneiss, in which are many veins and lenticular bodies of opaque white quartz; but it is believed that these veins are not the source of, and have no genetic relationship to, the deposits of quartz crystals. Three modes of formation of quartz crystals are recognized: first, primary fillings of fissures, vugs, solution cavities, and other open spaces; second, hypogene crystals, of primary or secondary origin, in pegmatites, particularly in vugs or in banded zones; and third, supergene crystals of quartz that grew in bedrock during or after the time when the latter was decomposed by weathering to saprolite. Many, if not most, of the quartz crystals in the areas studied are believed to have originated by the third method, and to such crystals, the designation "pocket quartz" is applied.

Both the quartz crystals and the vein quartz have been concentrated at the surface of the ground and in the upper part of the soil as a result of long continued residual weathering. Such concentrations do not necessarily indicate that other quartz of the same kind lies directly below in bedrock; on the contrary, such deposits are more likely to indicate that the veins, dikes, and supergene pockets have been eroded, to form the surficial deposits. This conclusion has been fortified by underground exploration at several sites and by the discovery of considerable subsurficial quartz at other sites where little or none appeared at the surface. These conditions make prospecting for pocket quartz a difficult and uncertain enterprise.

About 2,800 lbs. of quartz crystals that might be of oscillator grade were shipped from Virginia and North Carolina to the National Bureau of Standards for testing prior to Apr. 1944, and about 14% was certified to the Metals Reserve Corporation for purchase. More than half of this quartz was transmitted by the U. S. Geological Survey. Oscillator quartz of grades 1 and 2, weighing 17.18 lbs. and of grade 3, weighing 134.99 lbs, came from Virginia; and 71.86 and 165.03 lbs., respectively, were produced in North Carolina. The Metals Reserve Corporation paid $830.70 for the output from Virginia and $1,521,53 for that from North Carolina.

Most of the quartz crystals that are available in the Southeastern Atlantic States are of low grade, as shown by the preceding data. The reserves that are readily obtainable are small, and the outlook for future production is unfavorable. During World War II, however, much quartz was discarded because the users demanded oscillator plates with diameters ranging from a centimeter to an inch. These conditions have now changed, and much smaller plates are being cut. Hence, a part of the quartz of grade 3 that was formerly considered useless might now be utilized. --Auth.

1-1294. Runnels, Russell T. CEMENT RAW MATERIALS IN KANSAS: Kansas, State Geol. Survey, Bull. 134, pt. 2, p. 105-124, 5 figs., 3 tables, Apr. 1959, 12 refs.

All of the eastern one-third and much of central Kansas has abundant rock suitable for manufacture of portland cement. A diversified market for portland cement presently exists. Bulk transportation by truck in a N.-S. direction has not been fully utilized in Kansas. The recent development of a small vertical-kiln type of cement plant, which requires only about a twentieth of the investment needed for a conventional plant, could facilitate additional cement production in Kansas. --From auth. abs.

1-1295. Byrne, F. E., C. P. Walters, J. L. Hill, and L. Riseman. GEOLOGY AND CONSTRUCTION-MATERIAL RESOURCES OF MARION COUNTY, KANSAS: U. S. Geol. Survey, Bull. 1060-B, p. 63-93, 4 illus. (2 in pocket), geol. map scale 1:63,360, table, Mar. 1959, 10 refs.

Sources of construction materials in Marion County, Kansas, were studied as a joint project of the U. S. Geological Survey and the State Highway Commission of Kansas. The county is in S.-central Kansas at the W. edge of the Flint Hills.

Rocks of early and middle Permian age crop out extensively over the eastern two-thirds of the county. These rocks are composed of alternating beds of gray limestone, many of which are markedly cherty, and varicolored shale. Two formations of Early Cretaceous age at the surface in the western part of the county are the Kiowa shale, a marine deposit that rests disconformably on the Wellington formation of Permian age, and the Dakota sandstone, a series of interfingered lenses of shale and sandstone. In many parts of the county the Permian and Cretaceous rocks are covered by thin layers of sediments deposited by the wind and streams during the Quaternary period. These sediments, divided into 3 units, are shown on an accompanying geologic map as the Sanborn formation, terrace deposits and alluvium.

Limestone, the local material most useful in construction is suitable for use as aggregate, road metal, riprap, and structural stone. Sand from the Sanborn formation is used as road metal. Silt from the Sanborn formation and from terrace deposits might be used as mineral filler. --Auth.

1-1296. Scott, Glenn R., Frank W. Foster, and Carl F. Crumpton. GEOLOGY AND CONSTRUCTION-MATERIAL RESOURCES OF POTTAWATOMIE COUNTY, KANSAS: U. S. Geol. Survey, Bull. 1060-C, p. 97-178, 5 illus. (2 in pocket), geol. map scale 1:63,360, table, Apr. 1959, 29 refs.

Pottawatomie County lies in NE. Kansas at the juncture of the Big Blue and Kansas rivers. The Nemaha range, a long narrow anticline, trends southwestward across the eastern part of the county and exposes Pennsylvanian rocks at the surface 15 mi. W. of the normal outcrop area. Permian rocks crop out in the E. and W. The chert-bearing limestone beds in the western part of the county underlie the Flint Hills Upland, a part of the Osage Plains. The Flint Hills escarpment, formed by the chert-bearing limestone beds, bifurcates; one branch follows the Big Blue River and the other follows the Nemaha range in the eastern part of the county.

The Kansan glacier covered all but the SW. corner of the county. The wind deposited a thin mantle of loess over the upland and in some valleys. The larger streams in the county are bordered by a series of persistent terraces.

The Pennsylvanian system is represented by the Wabaunsee group which consists of thin fossiliferous limestone alternating with thick unfossiliferous silty shale beds. Intraformational channel sandstone beds occupy part of the interval between some limestone beds. Less commonly the channels were cut downward through several limestone beds and were filled with many feet of sand and carbonaceous material.

A shale bed 65 ft. thick trends southeastward across the center of the county where the Grandhaven, Jim Creek, Nebraska City and Grayhorse limestone members were not deposited and shale deposition was continuous. Several coal beds are exposed: 2 are locally 18 in. thick.

The Permian rocks belong to the Admire, Council Grove, and Chase groups.

The rocks of the Admire group include several beds of coquinoidal limestone, a platy limestone with mudballs, an earthy limestone, an algal limestone, and intervening beds of variegated and tan-gray silty shale. An intraformational channel sandstone is extensive in the Stine shale bed of the Hamlin shale member.

Rocks of the Council Grove group are alternating massive gray limestone beds and unfossiliferous variegated silty and clayey shale beds. The limestone units are generally thicker than those in the underlying Admire and Wabaunsee groups, but are thinner than those in the overlying Chase group. Some shale beds in the Council Grove group are not variegated but are light gray and fossiliferous.

Cherty limestone beds separated by variegated silty shale comprise the lower part of the Chase group. The youngest rocks in the area are the silty chalky limestone beds and silty calcareous shale beds of the middle part of the Chase group.

The Pleistocene deposits are of pre-Kansan, Kansan, and post-Kansan ages. Deposits of pre-Kansan and Kansan chert gravel crop out on divides in the eastern and S.-central parts of the county.

The Kansan glacier deposited clayey till, with erratics as much as 18 ft. in length over all but the SW. corner of the county. The till was deeply weathered during post-Kansan time. The pre-Kansan channel of the Kansas River N. of St. George was blocked with ice and subsequently filled with outwash which caused the river to flow southeastward through a series of spillways and diversion channels in Wabaunsee County. When the ice melted, the river cut its present channel south of St. George and Wamego. Fine sediments collected in ponds along the ice front and attained a thickness of almost 150 ft. in the NE. corner of the county.

Broad terraces were formed as alluvium filled the stream valleys in post-Kansan time. Along the Kansas River valley E. of Wamego 4 terraces and the flood plain were mapped. Along the smaller streams in the county, successively younger layers of alluvium were superimposed to form a single terrace level. The alluvium along the Kansas River ranges from 50 to 80 ft. in thickness.

Thin discontinuous deposits of loess crop in the western part of the county and on the plateau near Fostoria. The loess appears to be correlative with the Loveland and Peorian loess sheets, which are thicker and more continuous N. of Pottawatomie County.

Construction materials are available in sufficient quantity and of the necessary quality for use as concrete aggregate, road metal, mineral filler, riprap, and structural stone.

Aggregate for concrete is available from the alluvium of the Kansas and Big Blue rivers (source of most concrete aggregate now used), from the coarser glacial outwash, and from crushed limestone. Road metal is obtainable also from limestone gravel dredged out of small streams and from chert gravel in the old gravel deposits. Mineral filler is obtainable from the finer outwash and from the large glacial lake deposit in the NE. corner of the county. Riprap of good quality is obtained from the Neva limestone member of the Grenola limestone, Tarkio limestone member of the Zeandale limestone, Americus limestone member of the Foraker limestone, and from the Brownville limestone member of the Wood Siding formation. Eight limestone beds that vary greatly in color, hardness, and texture are satisfactory for structural stone. Other limestone in the area might be usable for special building purposes or for agricultural lime. --Auth.

1-1297. Grandone, Peter, L. E. Edwards, and William E. Ham. THE MINERAL INDUSTRIES OF OKLAHOMA IN 1957 AND 1958: Oklahoma Geol. Survey, Mineral Rept. 36, 24 pp., 13 tables, 1959.

Final statistics for 1957 show a record mineral production in Oklahoma valued at $804 million, of which petroleum, natural gas, natural-gas liquids, and coal contributed 94%. Zn, Pb, cement, gypsum, sand and gravel, and stone also were produced in appreciable quantities. Production of each commodity is reviewed. A listing of minerals produced and their marketed value in each of the 75 productive counties is given in a table.

Total value of 1958 mineral production in Oklahoma is estimated at $767 million, of which mineral fuels contributed more than 95%, nonmetals 4%, and metals less than 1%. Compared with 1957, substantial losses were reported for petroleum, coal, Zn, and Pb, and these losses were not offset by modest increases for natural gas, liquefied petroleum gases, cement, and sand and gravel. --W. E. Ham.

13. FUELS

See also: Geologic Maps 1-1074, 1-1086, 1-1091, 1-1097, 1-1100, 1-1111; Areal and Regional Geology 1-1113; Stratigraphy 1-1145, 1-1146, 1-1147; Geophysics 1-1186; Geochemistry 1-1219.

1-1298. Chilingar, George V. APPROXIMATE METHOD OF DETERMINING RESERVES AND AVERAGE HEIGHT OF FRACTURES IN FRACTURED ROCKS: AN INTERIM REPORT: Compass, v. 36, no. 3, p. 202-205, 3 pls.; March 1959, 2 refs.

The permeability of many limestone and dolomite reservoirs is very low, but production from these rocks is often higher than might be expected from the permeability of the cores. This anomaly is due to the fractured nature of the rocks. Determination of the size of fractures in laboratory is practically impossible. The writer is studying the flow conditions in formations which are characterized by distribution of fractures throughout the body of rock and is attempting to develop approximate methods for estimating reserves in these rocks. Derivation of some formulas necessary for the estimation of reserves are shown in plates. In deriving these equations, it was assumed that there is one fracture per 1 cm.^{2}. It was found that similar formulas had been developed by Kotyakhov in 1956. --A. C. Sangree.

1-1299. Perkins, Ronald D. PALYNOLOGY AS A STRATIGRAPHIC TOOL IN OIL EXPLORATION:

Compass, v. 36, no. 3, p. 206-21, 6 figs., March 1959, 8 refs.

Palynology may be defined as the study of pollen and spores, their dispersal, and applications. They have already been used in coal basin investigations and interpretation of Quaternary geology. Within the last few years, their stratigraphic usefulness has been tested with success. Plant fossils represent one of the most promising paleontological tools that has been made available to the oil industry within recent years. The field is relatively new, however, and much research and study are needed before their full value is realized. Many major oil companies have established palynological laboratories and are applying pollen and spore analysis as a means of subsurface geology interpretation. --Auth.

1-1300. Baker, E. G. ORIGIN AND MIGRATION OF OIL: Science, v. 129, no. 3353, p. 871-74, 2 figs., 2 tables, Apr. 3, 1959, 19 refs.

A relationship exists between the composition of crude oil and the solubility of the component hydrocarbons in dilute colloidal electrolyte solutions, suggesting that crude oil consists of hydrocarbons that were once solubilized in formation waters. It is not solubility in ordinary water or solubility in complete soap solution that correlates with the composition of oil, but, rather, solubility in soap micelles. Because it implies a possible unloading mechanism, this concept is attractive, for it follows that when a soap solution is diluted with water, the soap micelles disperse and the hydrocardons solubilized therein appear as discrete, filterable oil droplets.

Thus, it would seem that crude oil originates during the compaction of a sedimentary basin by virtue of the fact that sediment hydrocarbons dissolve in waters containing natural solubilizers and then come out of solution as oil droplets. The composition of crude oil as now understood is consistent with this hypothesis. And - most important - it is now possible to formulate meaningful questions, the answers to which, upon investigation in both field and laboratory, will go far toward enabling us to assess the validity of the mechanism presented here.

In addition to the implications regarding the composition of crude oil that are inherent in the hypothesis that crude oil collects from aqueous colloidal electrolyte solutions, there are several interesting implications from the geological viewpoint. To mention one, such a mechanism would lend credence to the suggestion that the source beds of petroleum are not necessarily unique accumulations of hydrocarbons in a limited area but, rather, may generally be coincident with the area from which water is expressed into the porous strata that eventually form the reservoirs. --Auth. summ.

1-1301. Whiting, Lester L. SPAR MOUNTAIN SANDSTONE IN COOKS MILLS AREA, COLES AND DOUGLAS COUNTIES, ILLINOIS: Illinois, State Geol. Survey, Circ. 267, 24 p., 7 figs., table, 1959, 24 refs.

Development of significant oil production from erratic sand lenses in the Ste. Genevieve carbonate sequence some 20 mi. N. of other production in E.-central Illinois has generated new interest in oil possibilities along the northern rim of the deep part (Fairfield basin) of the Illinois basin.

The Cooks Mills area of northern Coles and southern Douglas counties is a rectangular area of about 200 sq. mi. The first producer was completed in 1941, but important development did not follow until 1954. By the end of 1957 more than 600 holes had been drilled, resulting in 334 producing wells located in 5 different pools, and more than 3,000,000 barrels of oil had been produced from 5,170 proven acres. Reserves studies indicate that 7.5 million to 8 million more barrels of oil will ultimately be produced from these wells.

The producing sand commonly referred to as "Rosiclare" is older than true Rosiclare and is correlative with the Spar Mountain sandstone. It is suggested that the environment in which Spar Mountain sediments were deposited resembled that on the Bahama Banks today. Minor but important structural deformation on a low, southeastward dipping slope developed during Chester time, and the present sites of oil concentration are found along structural trends formed at that time. Post-Mississippian folding, resulting in major uplift along the LaSalle anticlinal belt just to the E., further modified the Cooks Mills area. Current structure maps on Mississippian horizons show a regional southwestward dip on which the earlier areas of positive deformation are reflected as noses or terraces with little or no closure. --Auth.

1-1302. Jordan, Louise. SECOND DEEPEST HOLE IN THE WORLD IN ELK CITY FIELD, BECKHAM COUNTY: Oklahoma Geology Notes, v. 19, no. 4, p. 88-89, Apr. 1959.

Shell Oil Company's deep test (No. 5 Rumberger) drilled to a depth of 24,002 ft. in Beckham County, Oklahoma, ranks second after Phillips Petroleum No. EE-1 University drilled to 25,340 ft. in Pecos County, Texas. Two 25-ft. cores were cut from 23,953 and 24,002 ft. with recoveries of 88 and 100% respectively. These are the deepest cores ever recovered. The Permian Quartermaster formation crops out at the surface, and Permian rocks are penetrated to a depth of 6,480 ft. The thickness of Pennsylvanian rocks penetrated is either 14,995 or 16,468 ft. depending on placement of the Mississippian boundary. The Pennsylvanian-Mississippian boundary is thus considerably lower in the column than that commonly reported in published literature. In Feb. 1959, the well was plugged back to 14,965 ft. --A. C. Sangree.

1-1303. Sandidge, John R. A REVIEW OF EDWARDS LIMESTONE PRODUCTION WITH SPECIAL REFERENCE TO SOUTH-CENTRAL TEXAS. (In: Symposium on Edwards Limestone in Central Texas): Texas, Univ. Pub. 5905, p. 131-52, pl. (in pocket), March 1959, 19 refs.

The discovery in 1922 of oil in the Edwards formation of S.-central Texas was of great importance because it opened a large area for exploration and development. Much credit is given to Edgar B. Davis, who pioneered the discovery, and to many other oil men who have carried Edwards exploration and development from the Sabine to the Rio Grande. The more recent discoveries of gas in the Edwards have established substantial reserves and created much interest in additional exploration. --Auth.

1-1304. Risser, H. E. EFFECT OF COAL INVENTORIES ON STABILITY OF THE COAL INDUSTRY: Illinois, State Geol. Survey, Circ. 268, 11 p., 6 figs., 5 tables, 1959.

This analysis of changes in past coal consumption and inventories was undertaken to determine the extent to which inventories contribute to the general stability or instability of the coal industry.

Coal inventories are of two types: 1) seasonal inventories built up during the summer for use during the winter, and 2) protective inventories, held to assure adequate supplies of coal in the event of an interruption in supply. Seasonal inventories tend to stabilize production by leveling out the troughs and peaks of seasonal consumption. Protective inventories tend to follow changes in the rate of consumption and thus to accentuate their effects. As a result, fluctuations in coal production far exceed those that might be expected on the basis of changes in the amount of coal used by consuming industries.

Studies of seasonally adjusted consumptions and inventories reveal a distinct pattern of behavior when significant changes in industrial activity occur. Such studies may be useful in forecasting changes in the demand for coal, and the information may be valuable to both producers and consumers in planning their operations and inventory policies. --Auth.

1-1305. Gordon, S. A., K. Yu. Volkov, and M. A. Mendovskiy. ON THE FORMS OF GERMANIUM IN COAL: Geochemistry [Geokhimiya], 1958, no. 4, p. 484-89, 6 tables, 4 refs.

The results permit the conclusion that Ge is contained in 2 forms in the investigated coals: 1) a form related to the organic coal mass, as humates of Ge, and 2) a form related to the mineral part of the coal. To the first form may belong the Ge amount taken into solution together with humic acids. In this sense a comparison of data on the forms of Ge content in ordinary brown coal and in its concentrate is very significant. Simultaneously with the coal enrichment, an enrichment of the concentrate by the organic form of the Ge content from 83.3 to 97.3% has occurred. --Auth.

1-1306. Green, R. BRAZEAU COLLIERIES LIMITED, NORDEGG, ALBERTA: Alberta Soc. Petroleum Geologists, Guide Book, Eighth Ann. Field Conf., Nordegg, 1958, p. 4-9, Aug. 1958; also pub. as: Research Council Alberta, Contr. Ser. no. 88.

Bituminous coal, suitable for use in locomotives, was discovered in western Alberta in 1906, and in the Brazeau region in 1908. Martin Nordegg, an official of the German Development Company, undertook establishment of a coal mine in the Brazeau region. This mine thrived during the First World War, but between 1924 and 1940 had to struggle to exist. After increasing production between 1940 and 1949, the mine closed in 1955 because of lack of markets. Two seams in the Lower Cretaceous Luscar formation were mined below surface at Nordegg, and a strip-mining operation was begun in 1946. From 1914 to 1955, 10 million tons of coal were produced - less than 1% of the reserves of the region. --Auth.

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See also: Geologic Maps 1-1088, 1-1102; Stratigraphy 1-1146, 1-1147; Geophysics 1-1190, 1-1191.

1-1307. Upham, Charles M. GEOLOGICAL INVESTIGATIONS IN ROADBUILDING: Better Roads, v. 29, no. 4, p. 44, 46, 48, Apr. 1959.

Geologists are extensively called upon to provide information on the best location for roads and the materials with which to build them. Geologic studies in the Nile delta of Egypt helped locate sand, gravel, and rock for crushing, saving time and haulage. Airphoto analysis and soil-resistivity surveys are relatively new and valuable tools for the geologist on road-construction projects. --M. Russell.

1-1308. Stoeckeler, E. G., and W. R. Gorrill. AIRPHOTO ANALYSIS OF TERRAIN FOR HIGHWAY LOCATION STUDIES IN MAINE: Photogramm. Eng., v. 25, no. 1, p. 85-97, 18 figs. incl. stereograms, maps, March 1959.

Airphoto interpretation techniques are especially useful for highway engineering terrain studies in wilderness areas where little or no detailed information on geology or soils is available. In Maine, time-consuming and expensive field reconnaissance surveys were reduced to a minimum by the intelligent use of aerial photography. Detailed field investigation and laboratory testing is still required to obtain information for final design purposes, especially in critical areas. The Maine State Highway Commission has successfully employed airphoto interpretation techniques for obtaining a variety of information valuable in various phases of highway engineering.

The four types of strip-studies described in this paper are only a few of many possible applications of this field. It is highly probable that more intensive and specialized photo interpretation studies will be made in the near future in Maine as well as throughout the nation. --Auth. concl.

1-1309. Bickel, F. D. DEMOLITION OF RIPPLE ROCK: Military Engineer, v. 51, no. 341, p. 172-77, 6 illus., maps, diag., May-June 1959.

Two basalt knolls, known as Ripple Rock, in the Seymour Narrows between Maud Island and Vancouver Island in the Inside Passage from Puget Sound to the Gulf of Alaska, have long been a hazard to ships. Several unsuccessful efforts to remove them were made by such means as barge-born drills in 1941 and 1945. From 1955 to 1958, a plan was undertaken in which tunnels were driven from Maud Island to the shoals, and 2,736,324 lbs. of Dupont "Nitramex" placed in the knolls. The largest non-atomic blast in history succeeded in clearing the obstruction to a minimum depth of 45 ft. --M. Russell.

1-1310. Mather, Kirtley F. GEOLOGY, GEOLOGISTS, AND THE AAAS: Science, v. 129, no. 3356, p. 1106-1111, illus., 4 ports., Apr. 24, 1959, ref.

Geologists were instrumental in the founding, in 1840, of what is now the American Association for the Advancement of Science (AAAS). Such famous men in geology as L. Agassiz, E. D. Cope, O. C. Marsh, W. B. Rogers, W. C. Redfield, J. S. Newberry, James Hall, and G. K. Gilbert were presidents or closely associated with the organization in its early years. An apparent decline later in the attention given, or responsibilities held, by geologists in the AAAS can be related to the establishment in 1888 of the Geological Society of America and, later, more specialized geological societies. Most geologists, however, have recognized the need for active participation not only in a society of their specialty but also in the forum of AAAS where the contributions of many disciplines of science are disseminated to the benefit of all. --M. Russell.

1-1311. Dapples, Edward C. BASIC GEOLOGY FOR SCIENCE AND ENGINEERING: 609 p., 224 figs. incl. illus., maps, diags., graphs, 57 tables, New York, John Wiley & Sons, Inc., 1959, refs.

The author has organized the book in 3 general units: earth materials, processes of erosion and deposition, and processes of crustal deformation and rock metamorphism. Each unit describes certain processes and organizes concepts in particular succession so as to complete a cycle of analysis, returning the reader to the beginning subject matter of the unit.

Following an introduction to geology, Chap. 2 concerns soil materials and includes varieties and distinction between sediment and soil, particle size distribution, grade scales, bulk properties which a sediment assumes by virtue of particle size, and elementary manipulation of size frequency data. The chapter closes with examination of the soil profile and its association with bedrock types. Chap. 3 introduces bulk physical and chemical properties of the Earth, beginning with the geothermal gradient and extending into pressure zones and distribution of chemical units. This discussion leads to the properties of solids, and in particular, minerals. Chap. 4 is a description of the properties of some 20 common rock-forming minerals grouped into those typical of igneous, metamorphic, and sedimentary rocks. Chap. 5 is devoted to igneous rocks and is organized around their chemical composition, minerals crystallizing from melts of changing precentage of silica, systems of classification, and characterizing features of intrusions and extrusions. In Chap. 6 the reader is returned to an analysis of soil-forming processes ending by characterizing the major soil groups. Chaps. 7, 8, 9, 10, and 11 are, in respective order, analyses of processes of streams, shorelines, ground water, wind deposition, and glaciation. The treatment is directed toward analyses of the processes involved and the erosional and depositional features which are developed. The last block of Chaps. 12, 13, and 14 begins with a study of sedimentary rocks, and in the last part of Chap. 12 deals with elementary concepts of stratigraphy. Chap. 13 is concerned with primary and secondary structures in rocks. Particular attention is paid to concepts of structural deformation, the geologic map and its characteristics, and interpretation of folds and faults in the field. The last chapter deals with metamorphic rocks and discusses the kinds of metamorphism; zones, facies, and grades of metamorphism; textures, structures and classification of such rocks. --Auth.

1-1312. Curtis, Neville M., Jr., comp. PUBLISHED PAPERS ON OKLAHOMA GEOLOGY IN THE YEAR 1958: Oklahoma Geology Notes, v. 19, no. 3, p. 51-71, March 1959, 211 refs.

Complete annotated list of papers on geologic subjects in Oklahoma for the year 1958 and an index to the list. --C. C. Branson.

1-1313. Goodman, Richard E. DETERMINATION OF SAND GRAIN SPHERICITY BY STEREO PHOTOMICROGRAPHY: Photogramm. Eng., v. 25, no. 1, p. 58-60, 2 illus., March 1959, 3 refs.

Accurate determination of the sphericity of sand grains is important in glacial and petroleum geology, geomorphology, and geochemistry. Photogrammetry makes possible an accurate measurement of the volumes 1) of the sand grains and 2) the volume of a circumscribing sphere, both of which are necessary to calculate sphericity. A method of photography and measurement is described. The process is slow and involved but could be modified for mass-produced studies. --M. Russell.

1-1314. Pafford, F. William, and Donald B. Prell. THE TERRAIN DATA TRANSLATOR: Photogramm. Eng., v. 25, no. 1, p. 70-75, 3 figs., 2 tables, March 1959.

A new photogrammetric measuring device known as the Terrain Data Translator (TDT) has recently been developed and field tested by the Benson-Lehner Corporation of Los Angeles, California. The primary purpose of the TDT is to provide ground cross-section and profile notes in digital form directly from the stereo model as viewed in the double projection, or Kelsh type, stereoplotter, or directly from a topographic map sheet. Preliminary test results indicate that this unit permits increased accuracy and significant savings in terms of both time and money. --From auth. introd.

1-1315. Pincus, Howard J. SOME APPLICATIONS OF TERRESTRIAL PHOTOGRAMMETRY TO THE STUDY OF SHORELINES: Photogramm. Eng., v. 25, no. 1, p. 75-82, 5 figs. incl. maps, March 1959, 16 refs.

Normal horizontal and normal oblique terrestrial photogrammetry applied to field and laboratory shoreline situations, respectively, yield results which nearly or fully meet the requirements of coastal engineering geology. The photogrammetric theory underlying this work is that presented by Zeller.

In studies of this kind terrestrial photogrammetry provides: topographic information which is synoptic, or nearly so; views of gentle beach features which present their outlines in their most conspicuous aspect; the opportunity to obtain the photography during weather which might prevent aerial work; the opportunity to collect samples while the photography is being obtained; probably a significantly lower operating cost than the cost of aerial work for the repeated mapping of discrete strips of shoreline.

A Speed Graphic camera has been used for recording beach profiles drawn by the image of a point source of light which is dragged over the beach along the desired line of profile.

Limitations of these techniques are discussed, as is a suggestion for future work. --Auth.

1-1316. Raasveldt, Henri C. DETERMINATION OF THE ANGLE OF DIP OF SEEMINGLY VERTICAL STRATA ON VERTICAL AERIAL PHOTOGRAPHS: Photogramm. Eng., v. 25, no. 1, p. 49-53, 5 figs., March 1959, 2 refs.

Most photogeologists are familiar with the phenomenon of perspectively overturned beds in stratified rock. The impression one receives from the photographs is that the strata seem to dip in the opposite direction from the actual one. Sometimes they also appear to be considerably steeper than they actually are, without reaching an overturned position. Also, the contrary is more or less familiar: that strata appear on the photographs to be less steep than they are in reality. A simple and rapid method of determining the true dip, without the use of a stereoscope, is described. --From auth. introd.

1-1317. Lucas, Elmer L. WHAT IS EXPECTED OF A GEOLOGIST?: Oklahoma Acad. Sci., Proc., v. 38, p. 75-77, 1958.

The geological profession like all others must meet the demands of industry, teaching and research. An understanding of geology requires basic training in allied sciences and a knowledge of the humanities. High school students should study the university curriculum and not bring a transcript with glaring deficiencies.

Memorizing of dates and names is only a small part of an understanding of the processes of the earth crustal evolutions. Fundamentals come first and industrial applications come later.

Industry requires scientific and technical knowledge with over 50% placed on other qualifications. Cooperation, ambition and a strong moral sense are essential. Industry expects the young geologist to think, write and express himself clearly.

Many varied fields of service are open to the geologist,such as minerals and fuels exploration, teaching and research for Federal agencies and private industry. The geological profession has grown along with the development of mineral resources. Modern business requires much committee work demanding expert talent. Some geologists have talents in the business world but many others have wonderful opportunities to make places for themselves in the geological profession. --Auth.

1-1318. Crosby, Gary W. INEXPENSIVE AIDS TO GEOLOGIC FIELD WORK: Compass, v. 36, no. 3, p. 193-201, 6 pls., March 1959, 4 refs.

A rock color chart may be constructed with cardboard, rubber cement, and color samples which may be obtained from any paint store. The 1948 Rock Color Chart of the National Research Council is used as a standard for color comparisons.

Using cardboard, scale, 2 biologic slides, and size-graded sand samples, a grain size scale may be constructed which corresponds to the Wentworth scale.

By eliminating all but the most essential reagents and instruments, and by arranging these in a compact carrying case, a blow pipe analysis kit can be assembled that is of considerable value to the field geologist. The outstanding feature of this kit is its portability. --Auth.

1-1319. McKelvey, Vincent E. RESOURCES, POPULATION GROWTH, AND LEVEL OF LIVING: Science, v. 129, no. 3353, p. 875-81, Apr. 3, 1959, 42 refs.

Analysis of the relations of population growth and level of living to natural and human resources yields several simple but important principles as follows: the means for man's subsistence increase with increasing constructive consumption of raw materials, energy, and especially ingenuity. Resources of usable raw materials and energy may be increased to an unpredictable extent by the development and application of ingenuity. The most fundamental stimulus to ingenuity is a basic ideology that challenges, encourages, and rewards individual initiative, freedom of thought, desire for economic gain, and thirst for knowledge. The attainment of a high standard of living requires that the ratio of consumption to consumers be high. Such a ratio can be attained most easily if the population is educated enough to understand the benefits and the means of family limitation, and to extend its control over its physical and human environments by peaceful means. --Auth.

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